NUCLEAR SCIENCE ABSTRACTS

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February 28, 1971

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Volume 25, Number 4, February 28, 1971

NUCLEAR SCIENCE ABSTRACTS

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

ISHIHARA, T., Accumulation of fallout ^{137}Cs in newborn infants, 23:50538
ISHIHARA, Toyokuki, Shielding effect of paraffin, water, soil, concrete, Fe, and Pb for high-energy neutrons, 23:51748

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

MELPHALAN
  effects on proliferation of cultured antigen-stimulated spleen cells from mice, dose-response curve for, 23:50820
MEMBRANE FILTERS
  design for removal of cell-free Streptococcus faecalus from bacteria cultures in fermentation tank, 23:49996 (UCRL-18667, pp 322-9)
MENDELEVIUM
  separation from einsteinium and fermium by electrolysis, 23:49772 (UCRL-18667, pp 277-312)
  separation from sodium acetate solutions by solvent extraction using sodium amalgam, 23:49772 (UCRL-18667, pp 277-312)
  stability of divalent state of, 23:49772 (UCRL-18667, pp 277-312)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. (**Los Alamos Scientific Lab., N. Mex.**). Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 6399 and 6445.

6258 (IN-1426) ANALYTICAL CHEMISTRY BRANCH ANNUAL REPORT, FISCAL YEAR 1970. Shank, R. C. (Idaho Nuclear Corp., Idaho Falls). Oct 1970. Contract AT(10-1)-1230. 186p. Dep. NTIS.

A general survey of special analytical services and of the methods and equipment that were developed or improved by the Analytical Chemistry Branch for FY-1970 is presented. The new and revised methods that have been established during the year are reported in detail in the appendix. Also presented is the support to the Branch by the Analytical Research Section. The special services described are the unique nonroutine work performed by the Branch. Services by the Mass Spectrometry Group included helium leak tests on MTR beryllium reflector down beam cans and determination of hydrogen in the Fuel Heatup Simulation Test. Services by the Spectrochemical Group included x-ray fluorescent analysis of EBR-II stainless steel fuel jackets to identify 304 and 316 stainless steel, and x-ray fluorescent determination of niobium in Rover fuel dissolution study samples. New and improved methods and equipment included x-ray fluorescent determination of silver in silver zeolites. Services by the Radio and Special Analysis Group included the separation of rare earths in stainless steel and Incoloy clad uranium–plutonium carbide fuel. The TRA Group continued to support Reactor Loop Sponsors with routine services and also did some special work on corrosion studies. Improvements in methods and equipment included the preparation of samples for the determination of ^{63}Ni by liquid scintillation counting, determination of ^{55}Fe by liquid scintillation counting and ^{59}Fe by gamma spectrometry, and analysis of Bettis Atomic Power Laboratory samples from cold crud loops for more reliable value of gamma emitting nuclides. Services by the Remote and Service Analysis Group included dissolution of a platinum–rhodium thermocouple sheath and analysis of uranium chloride-coated aluminum for U(IV) and U(VI). Improvements in methods and equipment included the determination of aluminum and zirconium by atomic absorption spectrophotometry, potentiometric determination of the ratio of oxygen to uranium in uranyl oxide, fluorophotometric determination of uranium in plant process equipment waste samples, and development of a corrosion resistant pipet for remote pipetting. Support by the Analytical Research Section included the fluidized bed process for manufacturing uranium aluminide, determination of the oxygen/uranium ratio of UO_2 in AlO_2, analysis of $Al^0 \cdot UCl_4 \cdot$ "X" samples, and chemical characterization of the uranium aluminide product. Method development included the separation of boron for the determination of isotopic composition by mass spectrometry; investigation of a rapid titrimetric method for the precise determination of uranium using iron(II) sulfate as the reductant; titrimetric determination of aluminum in aluminum dissolver product, spectrophotometric determination of aluminum in complexed dissolver product, spectrophotometric determination of zirconium in complexed dissolver product, atomic absorption spectrophotometric determination of aluminum and zirconium in complexed dissolver product, emission spectrographic determination of zirconium in the first cycle uranyl nitrate product, investigation of methods for determination of particle size and incipient fluidization velocity, and analysis of irradiated tungsten-bonded uranium carbide samples for burnup. (P.C.H.)

6259 (STI/PUB-253) ANALYTICAL CONTROL OF RADIOPHARMACEUTICALS. Panel Proceedings Series. Proceedings of a Panel on Analytical Control of Radiopharmaceuticals Held in Vienna, 7–11 July, 1969. (International Atomic Energy Agency, Vienna (Austria)). Jul 1970. 230p. (CONF-690725). IAEA $6.00.

Seventeen articles are included; separate abstracts were prepared for each. A brief article on conclusions and recommendations of the panel is also included. (P.C.H.)

For abstracts of individual papers see: 6267–6271, 6276–6279, 6286, 6343, 6384–6388, and 6412.

Chemical and Spectral Procedures

Refer also to abstracts 6323, 6326, 6387, 6388, 6390, and 6419.

6260 (CEA-N-1341, pp 3-93) CHEMICAL ANALYSIS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969–November 1969.

The activity of the Analytical Research Service is divided into three main fields: delivery of analytical results, education, and development of analytical methods. Some of these studies were carried out to improve accuracy or sensitivity (determination of F in W by volumetry); to develop new techniques or apparatus (in coulometry, atomic absorption, pulse polarography); for research of a general or fundamental nature. The work of the Nuclear Material Testing Section has continued: determination of elements with volatile fluorides (Mo, W, Va, Ru); testing of Pu and its alloys and compounds; analysis of C in nuclear materials; and testing of cladding materials (determination of impurities in Mg). In the Nuclear Fuel Analysis Section the emission, x-ray fluorescence, and mass spectrometric methods of analysis were improved. The activity of the Cadarache Analytical Laboratory is summed up. (France)

6261 (CEA-R-4040) ELECTROADSORPTION IN PULSE POLAROGRAPHY. APPLICATION TO THE STUDY OF SOME RARE EARTH ELEMENTS. Chapron, Yves (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov 1970. 132p. (In French). Dep. NTIS (U. S. Sales Only).

A theoretical treatment of electrode reactions allowed expressions to be derived for the Farady current. After briefly reviewing various known isotherms, it is shown how these may be used to derive an expression for the current in the case where the electrode kinetics are governed by the adsorption step. The kinetic expressions for electrode coverage are calculated along with the equations for the served pulse polarograms. The adsorption properties of organometallic complexes in pulse polarography were applied to a study of a series of rare earth elements. The gradients of the $i_p = f(c)$ plots for the various rare earths can be classified according to the atomic number of the elements. This effect was interpreted using the electronic structure of the lanthanides. It can be noted that the $i_p = f(c)$ relationships can be used to analyze a mixture of two known rare earths. Furthermore, it was possible to carry out rapid electrochemical kinetics measurements using integral pulse polarography. (auth)

6262 (EUR-4518) QUANTITATIVE ANALYSIS OF URANIUM-BASED CERAMIC MATERIALS BY MEANS OF X-RAY DIFFRACTION. Conti, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 22 Apr 1970. 76p. (In French). Dep. NTIS (U. S. Sales Only). EUR FF 11.-.

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

X-ray diffraction may be conveniently used for the quantitative analysis of uranium-based ceramic materials (UC_2, U_3O_8, $UC-UC_2$, etc.) since this method is rapid, nondestructive, and requires only a small amount of material. A study was made of the various factors on which quantitative analysis depends, namely the grain size of the powders, preferential orientation effects, the method of assembling the samples, and the degree of crystallisation of the products. With the use of the various x-ray diffraction methods the said ceramic materials were determined in each other and in their mixtures with sufficient accuracy (within ±2% for 50 to 100% concentrations). These main methods were divided into two categories: comparative methods and internal standard methods. The comparative methods were used for analyzing the binary mixture $UO_2-U_3O_8$, for determining traces of U_3O_8 in UO_2, UO_2 in UC, and for analyzing the binary mixture $UC-UC_2$. The accuracy obtained was within ±2% for the high concentrations (50 to 100%) and within about 6% for the 0 to 50% concentrations. The internal standard methods were used for analyzing the ternary mixture UO_2-UC-U, for determining UC in UC_2, with application of the UC_2 stoichiometry to the calculation, and for UC_2-C(graphite) determination. The accuracy obtained was within about 2 to 3% (10 to 100% concentration). Comparisons were made with the Debye-Scherrer photographic method, which, although less accurate, is indispensable when only a small amount of sample is available. A calculation was made of the sensitivity of detection of the various compounds in their mixtures; the detection limits for UC_2 and UO_2 in UC reach values of about 0.04%. (auth)

6263 (FOA-4-4416) ON SEPARATION AND DETERMINATION OF FLUORINE. II. DETERMINATION OF 2 TO 7 MICROMOLE FLUORINE THROUGH WILLARD-WINTER DISTILLATION AND SPECTROPHOTOMETRIC ANALYSIS. Andersson, L.-H.; Gelin, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Feb 1970. 21p. (In Swedish). Dep. NTIS (U. S. Sales Only).

A method for determination of small quantities of fluorine in the presence of plutonium was developed. The precision was studied. Samples containing 5 micromoles of fluorine were analyzed, with a standard deviation of 0.04 micromole. (auth) (Sweden)

6264 (MG/D-431/70) PROJECT MG/DA/297: THE DETERMINATION OF TRACE AMOUNTS OF TANTALUM IN STEELS. (British Steel Corp., London (England). Inter-Group Labs.). [1970]. 13p. Dep. NTIS (U. S. Sales Only).

In certain steels manufactured for nuclear engineering purposes, the presence of trace amounts of tantalum is highly undesirable because an active radioisotope is formed under neutron bombardment. Precipitation with phenylarsonic acid using niobium and zirconium as carriers forms the basis of a satisfactory procedure for the determination of this tantalum. Tantalum in the precipitate is isolated from interfering elements by solvent extraction and its content determined by the formation of a coloured complex with pyrogallol. The method is not rapid, and a batch of six samples plus a reagent blank would require more than one day for completion. Trials of an alternative, more rapid method, using phenylfuorone as colorimetric reagent, in which preliminary precipitation is unnecessary, were less satisfactory. (auth) (UK)

6265 (NLCO-1078) SIMULTANEOUS DETERMINATION OF 22 IMPURITY ELEMENTS IN THORIUM MATERIALS USING A PRODUCTION CONTROL QUANTOMETER. Blank, G. R.; Reusch, J. K. (National Lead Co. of Ohio, Cincinnati). 2 Oct 1970. Contract AT(30-1)-1156. 30p. (CONF-701017-1). Dep. NTIS.

From 14th Annual Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

A rapid, direct-reading emission spectrometric method is described for determination of 22 impurities in ThO_2 using a 2-meter Production Control Quantometer. The ThO_2 samples are mixed with 6% AgCl-LiF(11:1 carrier), and 100-mg charges are excited in a dc arc of 14 amperes. Use of a programmed series of pre-integration and total-integration timers minimizes spectral background effects and permits optimum integration of the spectral response for each element regardless of its volatilization rate. The method permits the simultaneous determination of the following elements: Al, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Si, Sn, V, Zn, and Zr. The lower reporting limits are 0.1 ppM for B and Cd; 5.0 ppM for Fe, Si, Zn, and Zr; and 1.0 ppM for all other elements determined. Precisions range from 10 to 30% relative at the 95% confidence level. Compared with spectrographic methods previously used, the direct-reading method eliminates costs of photographic plates, reduces elapsed time for analysis by approximately 40%, and saves 1 to ½ man hours on the analysis of one sample and ¾ man hour on each additional sample. (auth)

6266 (NLCO-tr-10) SPECTROPHOTOMETRIC DETERMINATION OF BORON IN URANIUM, ALUMINUM, AND MAGNESIUM: EXTRACTION OF MONOMETHYLTHIONINE TETRAFLUOROBORATE. Federgruen, Ludmila; Abrao, Alcidio (Instituto de Energia Atomica, Sao Paulo (Brazil)). Translated for National Lead Co. of Ohio, Cincinnati, from report IEA-165. 14p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 7396.

6267 QUALITY CONTROL OF RADIOPHARMACEUTICALS AND ITS ORGANIZATIONAL ASPECTS. Iya, V. K.; Gopal, N. G. S. (Bhabha Atomic Research Centre, Bombay). pp 31-50 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

Methods for the quality control of starting materials in the production of radiopharmaceuticals, as well as for the control of the finite products, are reviewed. The various types of purity criteria are defined. As an example for the organization and running of a radiopharmaceutical control laboratory, the situation in the Bhabha Atomic Research Centre, Trombay, is presented. (auth)

6268 ANALYTICAL CONTROL OF RADIOPHARMACEUTICALS BY THE SPANISH NUCLEAR ENERGY BOARD (JEN). del Val Cob, M.; Rebollo Garrido, D. V.; Casas Medina, F. (Junta de Energia Nuclear, Madrid). pp 51-60 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

Radiopharmaceuticals currently produced in the Junta de Energia Nuclear, Madrid, are enumerated and their control is described. Several suggestions are made on the possible role of the IAEA in the field of radiopharmaceuticals. (auth)

6269 METHODS OF TESTING RADIOPHARMACEUTICALS USED BY THE ARGENTINE NATIONAL ATOMIC ENERGY COMMISSION (CNEA). Mitta, A. E. A.; Radicella, R. (CNEA, Buenos Aires). pp 61-2 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

The chemical, physical, and biological methods for testing radiopharmaceuticals used by CNEA are listed. For radioactive purity test and activity determination, the radioisotopes are calibrated with conventional instruments and techniques. (P.C.H.)

6270 ANALYTICAL CONTROL OF RADIOPHARMACEUTICALS IN NORWAY. Steinnes, E. (Instituut for Atomenergi, Kjeller, Norway). pp 63-8 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

A review is presented of the radiopharmaceutical control unit in Norway. The equipment and methods are described. Some particular problems that apply to small producers of radiopharmaceuticals are emphasized. The cooperation among Scandinavian countries in preparing monographs for the Pharmacopoeia Nordica is outlined. (auth)

6271 POSSIBLE ARTIFACTS IN THE CHROMATOGRAPHICAL DETERMINATION OF RADIOCHEMICAL PURITY OF ^{35}S- AND ^{75}Se-LABELLED METHIONINE. Galatzeanu, I. (Inst. of Atomic Physics, Bucharest). pp 189-99 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

Studies were made on the radiochemical purity of ^{75}Se-labeled selenomethionine using paper and thin-layer chromatography in nitrogen atmosphere and in air. It was concluded that the accuracy in the determination of the radiochemical purity of L-selenomethionine-^{75}Se by paper- or thin-layer chromatography depends to a great extent on storage and handling in the absence or presence of air because its oxidation leads to double spotting. (P.C.H.)

XUM

Radiometric and Radiochemical Procedures

Refer also to abstracts 6386, 6515, 6519, 6624, 6725, and 6730.

6272 (CISE-N-118) RADIOCHEMICAL STUDIES FOR RADIOACTIVITY DETERMINATIONS ON MARINE SEDIMENT SAMPLES: ^{137}Cs, ^{125}Sb, AND ^{60}Co. Giacoletto, C.; Triulzi, C. (Centro Informazioni Studi Esperienze, Milan (Italy)). Sep 1970. 42p. Dep. NTIS (U. S. Sales Only).

The analytical procedure for the separation and determination of ^{137}Cs, ^{125}Sb, and ^{60}Co, contained at low levels in marine sediment samples, is described. The whole procedure can be used not only to determine such radionuclides, but also ^{90}Sr, ^{144}Ce, ^{147}Pm, and ^{155}Eu. In addition, results are reported that were obtained by applying this procedure to some sediment samples collected in the Ligurian Sea on February 4, 1966, and the radioactivity due to each radionuclide considered is plotted as a function of the sediment thickness. (auth)

6273 (MLM-1324) INTRODUCTION TO RADIOCHEMICAL TECHNIQUES. Kirby, H. W. (Mound Lab., Miamisburg, Ohio). 20 Nov 1970. Contract AT-33-1-GEN-53. 47p. Dep. NTIS.

A view of instrumental techniques available to the chemist for analytical purposes is presented. Topics covered include: basic principles, detection of radiation, and practical considerations. (M.C.G.)

6274 ^{185} ^{181}W IN ATMOSPHERIC PRECIPITATIONS AT NIIGATA IN 1968–69. Sotobayashi, Takeshi; Suzuki, Toshio; Noda, Tomohiko (Niigata Univ., Japan). Bull. Chem. Soc. Jap.; 43: 3005-7(Sep 1970).

Unexpected fallout activities with a unique and marked 57.5-keV photon were recently found in 16 precipitation samples between Dec. 21, 1968, and May 20, 1969, at Niigata. In order to identify these unknown radioactivities, a systematic chemical-separation procedure was applied to a precipitation sample (64 l) collected on Dec. 25, 1968. For the purpose of reinforcing the chemical separation procedure, a sample solution for chemical analysis was prepared by the alkali fusion of the residue, followed by hot-water extraction. Sodium tungstate was added to the sample solution as a carrier, and a purified tungsten trioxide was obtained by the usual cinchonine–HCl method for tungsten analysis. A nuclide with a 57.5-keV photon was recovered nearly quantitatively, as was found by comparing the photopeak area at 57.5 keV between the residue and the trioxide. It was concluded that the unknown activities in question originate from radiotungsten isotopes, $^{181,185}W$. An explanation is given for the belief that radiotungsten occurred in the chemical form of WO_3. (P.C.H.)

6275 EFFECT OF THE BETA SPECTRUM ON SELF-ABSORPTION OF BETA RADIATION FROM ^{14}C. Wood, Kenneth G. (State University Coll., Fredonia, N. Y.). Int. J. Appl. Radiat. Isotop.; 21: 581-6(Oct 1970).

By integration of the beta spectrum for ^{14}C, and application of a formula for the absorption of monoenergetic beta rays, self-absorption was calculated for thin layers of carbohydrate. The absorption coefficient was shown to increase from 0.2 at 6 mg/cm^2 to over 1.05 at near-zero thickness. Absorption rather than scattering was shown to be the prime source of error in detection at near-zero thickness. It was recommended that the thickness range of 0 to 0.5 mg/cm^2 be avoided in making counts by the Geiger method, or, if this is not possible, that the 0 to 30-keV electrons be excluded from the count. (auth) (UK)

6276 QUALITY CONTROL AND CHEMICAL ANALYSIS OF RADIOPHARMACEUTICALS AT A SMALL RESEARCH CENTRE. Kim, Y. S. (Atomic Energy Research Inst., Seoul). pp 83-97 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

The methods used for the quality control and chemical analysis of radiopharmaceuticals at the Korean Atomic Energy Research Institute are described. Chromatographic techniques (including paper, thin-layer, and ion-exchange) proved to be simple and effective means for studying radiopharmaceuticals. Results of a study of radioiodinated human serum albumin by electrophoresis and degradation are presented as well as the results of a study of the stability of selected radiopharmaceuticals. Comparative studies of imported and Korean manufactured products are also presented. (auth)

6277 LIMITS OF ACCURACY IN THE DETERMINATION OF PURITY BY THIN-LAYER AND PAPER CHROMATOGRAPHY. Mellish, C. E. (Radiochemical Centre, Amersham, Eng.). pp 115-25 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

The factors determining the accuracy with which a purity figure can be derived from a paper or thin-layer chromatogram of a radioactive substance are discussed. An approximate expression is derived for the standard deviation of the fractional amount of impurity present due to counting statistics, in terms of the quantities measured on the chromatogram. The examples and graphs presented show in particular the importance of accurate background determination. (auth)

6278 DETERMINATION OF INORGANIC RADIOIODIDES IN ^{131}I-LABELLED COMPOUNDS BY MEANS OF THIN-LAYER CHROMATOGRAPHY. Alvarez, J. (Mexican National Nuclear Energy Commission, Mexico City); de Salas, N. G. B.; Raban, P.; Mitta, A. E. A. pp 127-9 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

A method was devised for the separation and determination of inorganic radioiodides in iodine-131-labeled compounds by thin-layer chromatography and autoradiographic means. HCl (1 N) was found to be the most suitable solvent. The method is considered suitable for rapid control procedures in situations where it is not easy to obtain various chromatographically pure solvents. (P.C.H.)

6279 RADIOMETRIC TITRATION OF INACTIVE AND RADIOPHARMACEUTICALS. Toelgyessy, J. (Slovak Technical Univ., Bratislava); Braun, T. pp 201-12 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

Radiometric end-point detection can be used in the analysis of both inactive and radiopharmaceuticals. Papers published so far mainly describe the determination of inactive preparations with a radioactive standard solution. Naturally, the method can also be applied to the analysis of radiopharmaceuticals. In most cases precipitate formation was used but recently procedures have been recommended in which the very sensitive complex formation reactions and ion-exchange separations are used. The latter method was used for determining cyanocobalamin preparations by titrating the cobalt content with standard EDTA solution after decomposition with ozone. The iron content of Tinctura Ferri aromatica preparation was determined in the same way. Radiometric titrations may also be applied to the determination of the specific activity and carrier content of radiopharmaceuticals. In this paper the principles, methods, and the practical aspects of radiometric titrations are treated, together with their applicability to the analysis of pharmaceuticals. The methods developed are described and some new suggestions given for the analysis of radiopharmaceuticals by radiometric titration. (auth)

Activation Procedures

Refer also to abstracts 6290, 6473, and 6475.

6280 (BNWL-1183-6) THE MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report to the NASA Manned Spacecraft Center, July 6, 1970–October 4, 1970. Brodzinski, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Oct 1970. Contract AT(45-1)-1830. 13p. Dep. NTIS.

The elemental concentrations of the fecal samples from the Apollo 12 and 13 missions are being determined by neutron activation and gamma analysis of the induced radionuclides. Some samples show abnormally high concentrations of gold. Packets of the capton used as the outer thermal coating of spacecraft were proton irradiated at 108, 375, and 600 MeV. The ^{7}Be and ^{22}Na excitation functions from this material are reported. The cross sections of these induced radionuclides are compared to the previously measured activities in the "skin" from the Apollo 8 and 12 mission spacecraft to yield particle fluxes of >16 p cm^{-2} sec^{-1} and >29 p cm^{-2} sec^{-1} incident on those spacecraft respectively. The concentration of ^{210}Po in a piece of the outer thermal coating of the Apollo 12 spacecraft was determined. The origin of the ^{210}Po is assumed to be the escaping decay products from the uranium in the moon. The average lunar surface uranium concentration of 0.061 ppM determined in this manner appears to be too low by a factor of ~6 or 7 based on measurements of moon rocks and fines returned by the Apollo 11 and 12 missions. The construction of a semi-portable, multi-purpose gamma spectrometer system is proposed. Suggested applications and a description of the high-efficiency, low-background

whole-body counter and sample counter combination are given. (auth)

6281 (NP-18566) NEUTRON ACTIVATION DETERMINATION OF NITROGEN IN STEELS AND NIOBIUM. Guazzoni, Paul (Grenoble Univ. (France)). 1970. 66p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Grenoble Univ. (France). Faculte des Sciences.

The determination of nitrogen by neutron irradiation in iron and steel matrices and in Nb was studied. The following two reactions were used, $^{14}N(n,2n)^{13}N$ and $^{14}N(n,p)^{14}C$, and in each the sensitivity and measurement limit (better for the reaction leading to ^{14}C), the precision, and the interferences were investigated. The speed of analysis favors the reaction leading to ^{13}N, while only that giving ^{14}C can be used to measure small traces. The nitrogen separation methods suitable for each of these matrices were studied. (France)

6282 MEASUREMENT OF WHOLE BODY CALCIUM AND SODIUM BY NEUTRON ACTIVATION ANALYSIS IN THE LIVING SUBJECT. Chamberlain, M. J.; Fremlin, J. H.; Peters, D. K.; Philip, Helen (Birmingham Univ., Eng.). Strahlentherapie, Sonderbaende; 67: 178-85(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Measurements of total-body sodium were made in cadavers and three living subjects by a neutron activation technique. A cyclotron was used as a source of neutrons of energy 3 to 4 MeV and the induced gamma radiation measured in a whole-body counter with spectroscopic analysis facilities. The radiation dose was approximately 1 rem. Thus, the technique is safe and the radiation dose low enough to permit sequential studies in the same subject. Repeated activation of the same cadaver showed that the results are reproducible. The technique may be useful in the study of generalized bone disease offering a substantial improvement in sensitivity over present methods. Total-body sodium by activation was approximately 15% greater than total exchangeable sodium in each of the three living subjects studied. (auth)

6283 PRELIMINARY RESULTS FROM IN VIVO MINERAL METABOLISM STUDIES ON BONE BY NEUTRON ACTIVATION. Comar, D.; Riviere, R.; Raynaud, C.; Kellershohn, C. (Service Hospitalier Frederic Joliot, Orsay, France). Strahlentherapie, Sonderbaende; 67: 186-94(1968). (In French).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

In vivo neutron activation analysis in man was used to study bone mineral metabolism. Neutron irradiation was directed against the antero-medial surface of three normal tibias and one with callus after an old fracture. Measurements of the radioactivity induced allows the calculation of the ratios of bone Ca/Na, Ca/Cl, and Na/Cl and of the rapidly exchangeable bone sodium. (auth)

6284 INTERNAL-REFERENCE METHOD FOR THE DETERMINATION OF RUBIDIUM BY PHOTON-ACTIVATION ANALYSIS WITH STRONTIUM USED AS THE REFERENCE ELEMENT. Tsai, Hui-tuh; Kato, Toyoaki; Oka, Yoshinaga (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 43: 2823-7(Sep 1970).

A method is described for the determination of rubidium by activation analysis with bremsstrahlung photons, with strontium used as the internal-reference element. The method is based on the γ spectrometric measurement of the ^{84}Rb activities produced by the $^{85}Rb(\gamma,n)$ reaction and on the comparisons of those activities with that of ^{83}Rb arising from strontium as a result of the (γ,p) reaction. The yields of various photonuclear reactions in rubidium and in strontium have also been examined as a function of bremsstrahlung maximum energies up to 60 MeV, and the best conditions for the determination of rubidium are proposed. When the maximum energy was set at 18 to 20 MeV, no interfering reactions occurred; a rubidium content down to about 2 μg can be determined accurately. A comparison of solid-state and scintillation γ spectrometry in this method has also been included with respect to the sensitivity and the selectivity. (auth)

6285 ACTIVATION ANALYSIS OF GOLD-BEARING SCRAP SOLDERS. Shanks, D. E.; Broadhead, K. G.; Heady, H. H. (Bureau of Mines, Reno, Nev.). Int. J. Appl. Radiat. Isotop.; 21: 671-6(Nov 1970).

Neutron activation analysis was used to meet the metallurgical research requirements for the rapid, nondestructive, analysis of Sn-Pb solders to which Al had been added to effect a phase separation of Au. The 2.8-MeV neutrons from the (D,d) reaction were used to activate Au. Although this reaction was interference-free, the relatively low neutron flux precluded detection of Au below ~50 ppM. The other elements of interest (Sn, Pb, Al, and Sb) were determined by the use of 14.8-MeV neutrons. Three separate irradiations were necessary to take advantage of the half-life differences in the radio nuclides produced and thereby achieve a direct instrumental analysis of the four elements. If only Au and Al were to be determined, approximately 24 solder samples could be analyzed per day, but if all five elements were to be determined, 2 additional days were needed to complete the analysis. (auth) (UK)

6286 ANALYTICAL CONTROL OF RADIOPHARMACEUTICALS IN THE DEPARTMENT OF CHEMISTRY, REACTOR CENTRE, SEIBERSDORF. Sorantin, H. (Osterreichische Studiengesellschaft fuer Atomenergie, Vienna). pp 69-81 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

Control procedures for target materials and processed radiopharmaceuticals are described, with emphasis on the use of radioactivation analysis. (auth)

6287 IDENTIFICATION OF ORIGIN OF GLASS BY NEUTRON ACTIVATION ANALYSIS IN A FORENSIC CASE. Schmitt, R. A.; Smith, V. (Oregon State Univ., Corvallis). J. Forensic Sci.; 15: 252-60(Apr 1970).

Two small shards of glass taken from the hair of a girl who was exposed to an impacted $10 \times 10''$ glass door light and injured with the subsequent loss of one eye were subjected to nondestructive neutron activation analysis to determine the source from four possible manufacturers on behalf of the plantiff. Gamma spectra were taken with a 30-cc Ge(Li) detector coupled to a 4096 channel analyzer revealed 70 or more γ peaks attributed to over 17 different trace elements and one major element. Spectra of the four known glass specimens were distinctly different from one another. Agreement of γ spectra between the small evidence glass shards and only one of the four known specimens resulted in identification and acknowledgement of origin of the glass shards. (auth)

6288 RARE-EARTH ACTIVATION ANALYSIS: IMPROVEMENT AND APPLICATION TO STRETISHORN DIKE AND DULUTH COMPLEX. Denechaud, E. Barton. Madison, Wis.; Univ. of Wisconsin (1969). 159p. University Microfilms Order No. 69-22,370.

Thesis.

A 20-cm^3 Li-drifted Ge detector was applied to the neutron activation analysis of the rare earth elements, chemically separated as a group but not individually. Counts were taken at approximately 6 hr, 3 days, 10 days, and 6 wk after irradiation, and analyses for twelve elements developed. Attainable experimental uncertainties for geologic samples were estimated at 2% or better for La, Ce, Sm, Eu, Tb, and Lu, 4% for Yb, around 10% for Dy and Ho, and 15 to 25% for Gd, Nd, and Er. The peaks used in the analyses were selected on the basis of their intensity and their freedom from interfering peaks. Hidden interfering activities, peak-broadening, and minute counting-geometry fluctuations were found to be potentially important error sources, and means for checking for these were incorporated in the general data-treatment procedure. The developed method was applied to suites of samples from the Stretishorn composite basalt-rhyolite dike of Iceland and the Duluth gabbro complex of northern Minnesota. The relative rare earth abundances in the dike are consistent with previously proposed hypotheses that the basalt phase contains a 10% rhyolite impurity and that the transition zone is, to a first approximation, a linear mixture of rhyolite and basalt. Relative to the general mixing patterns, La, Ce, and Tb show smoothly deviant concentration gradients across the rhyolite and transition zones. The rhyolite zone was found to have an anomalous Eu depletion far greater than can readily be accounted for by generation either by basalt-magma fractionation or by country rock assimilation. The results of the preliminary survey represented by the Duluth complex analyses support a hypothesis that at least the Bald-Eagle intrusion, a subunit, was formed by a similar process and from a similar liquid to those believed involved in the formation of the Kiglapait intrusion of Laborador. (Diss. Abstr. Int., B)

6289 PRIMENENIE YADERNYKH IZLUCHENII DLYA ANALIZA VESHCHESTVA. (Use of Nuclear Radiation in Analysis of Substances). Bibinov, S. A.; Kaipov, R. L.; Petrenko, V. D.; Romanov, M. M.; Khaidarov, A. A. Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). 260p.

Generalized and factual data are given on the development and use of activation analysis and γ spectrometers in resolving problems in geophysics. The problems on the use of activation analysis for the determination of W, Pb, and Hg, and other heavy elements in rocks, ores, and products of their enrichment are discussed. Detailed descriptions are given for the construction and design of

radioisotopic devices and the results of their operation in the industry. The economic efficiency of the methods proposed are also given. (530 references). (tr-auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 6399, 6402, 7850, and 7851.

6290 (UCRL-19530, pp 270-308) PHYSICAL AND INORGANIC CHEMISTRY. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

Topics covered include: a new isotope of element 104, chemical separation of rutherfordium, search for superheavy elements, polarographic reduction in solutions of Cf(III) and Es(III), thermochemistry of rare earth chlorocomplex compounds, valence states of iron in glass and of uranium in calcium fluoride single crystals, oxidation states and site symmetries of CaF_2:U crystals, pottery analysis by neutron activation, surface profile analysis by ^3He activation, determination of oxygen by ^3He activation, extraction of $HReO_4$ and $HAuCl_4$ by TOPO, anion exchange in mixed organic-aqueous solutions, hydration in organic solvents, and coordination of fluorides and chlorides with alcohol and phenol. (M.C.G.)

Chemical Properties

Refer also to abstracts 6840 and 8101.

6291 (ANL-Trans-863) INVESTIGATION OF NEW INORGANIC AND HETEROORGANIC FORMS OF ASTATINE. Norseev, Yu. V.; Khalkin, V. A. Translated for Argonne National Lab., Ill., from Chem. Zvesti; 21: 602-10(1967). 10p. (CONF-660966-1). Dep. NTIS.

From Radiochemical Conference, Bratislava, Czechoslovakia.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 42928.

6292 (ARH-1309) HYDROXYLAMINE NITRATE FROM HYDROXYLAMINE SULFATE. Bruns, L. E.; Swafford, S. W. (Atlantic Richfield Hanford Co., Richland, Wash.). 3 Jul 1969. 6p. Dep. NTIS.

Hydroxylamine nitrate is used as a reducing agent to convert Pu to the 3+ oxidation state. A simplified process was devised, which converts hydroxylamine sulfate to hydroxylamine nitrate by cation exchange using nitric acid as the eluting solvent at a savings factor of about three times over the present method. This method would provide enough hydroxylamine nitrate to satisfy the needs of Pu recovery and Purex processing. (M.C.G.)

6293 (IS-Trans-84) ELECTROCHEMICAL BEHAVIOR OF THORIUM IN MOLTEN SODIUM CHLORIDE AND AN EQUIMOLAR MIXTURE OF POTASSIUM CHLORIDE AND SODIUM CHLORIDE. Smirnov, M. V.; Kudyakov, V. Ya.; Nosokhin, Yu. V.; Krasnov, Yu. N. Translated from At. Energ. (USSR); 28: 419 (1970). 4p. Dep. NTIS.

Equilibrium potentials of Th for various concentrations and temperatures in molten NaCl and KCl-NaCl (50 mole % NaCl) were measured relative to a chlorine electrode. Empirical isotherm equations were obtained, which indicated that a Th electrode is reversible to a mixture of its Th^{2+} and Th^{4+} ions. Equations were also obtained for: temperature relationships of the apparent standard potentials (in volts) of Th/Th(II) and Th/Th(IV) electrodes; temperature relationship of the apparent equilibrium constants of the reaction $Th^{4+}_{molten} + Th_{solid} \rightleftharpoons 2Th^{2+}_{molten}$; and relationship between the equilibrium potential of Th and its total concentration $Th = Th^{2+} + Th^{4+}$. (P.C.H.)

6294 (ORNL-tr-2407) DESIGN OF AN ELECTROLYTIC CELL AND PLANNING OF AN EXPERIMENTAL STATION FOR DIRECT REDUCTION OF PLUTONIUM(IV). Roth, B. F.; Roos, W. (Gesellschaft fuer Kernforschung, m.b.H., Karlsruhe (West Germany)). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report NP-18167. 17p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 19048.

6295 (RD/B/M-1589) REVIEW OF THE SOLID-SOLID REACTIONS OF CARBON AND SILICON CARBIDE WITH URANIUM DIOXIDE AND OF OXIDATION OF SILICON CARBIDE. Crofts, J. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1970. 36p. Dep. NTIS (U. S. Sales Only).

The production of uranium carbides by the carbothermic reduction of UO_2 is reviewed and the effects of CO pressure and stoichiometry of UO_2 on the rate and mechanism of UO_2-C reactions are discussed. Reactions of SiC with UO_2 and the oxidation of SiC by gases and by SiO_2 are considered. The inhibition of SiC oxidation by added gases and the possible catalytic effect of fission products of uranium on the UO_2-C and UO_2-SiC systems are also discussed. (auth) (UK)

6296 ELECTRONIC NATURE OF PARAMAGNETIC OXYGEN SPECIES COMBINED WITH METAL IONS AT SURFACE AND IN SOLUTION. Setaka, Morio; Kwan, Takao (Tokyo Univ.). Bull. Chem. Soc. Jap.; 43: 2727-31(Sep 1970).

ESR spectra of adsorbed oxygen species were investigated on cadmium, cerium, and uranium oxides supported on alumina. The principal g values, g_x, g_y, and g_z of the oxygen species were computed and compared with those on the other metal oxides. It was pointed out that the principal g values observed on cerium and uranium oxides are interpretable by a peroxy-like model rather than an O_2^- radical. ESR spectra due to radicals formed on mixing solutions of VO^{2+} or UO_2^{4+} (containing Ti^{3+}) with H_2O_2 were also investigated by a rapid-mixing flow technique. The g value of the radicals was very close to the isotropic one of the peroxy-like species adsorbed on the corresponding metal oxide. The electronic nature of the interaction of oxygen species with metal ions at surface and with those in solution is comparatively discussed. (auth)

6297 ACTIVATION PARAMETERS FOR THE EXCHANGE REACTIONS BETWEEN EuEDTA$^-$ AND Eu(III), AND Am(III). D'Olieslager, W.; Choppin, G. R.; Williams, K. R. (Florida State Univ., Tallahassee). J. Inorg. Nucl. Chem.; 32: 3605-10 (Nov 1970).

The activation parameters were determined for the exchange between Eu^+(III) and EuEDTA$^-$ and Am^+(III) and EuEDTA$^-$. The values of $\Delta H\dagger$ were 11.9 (Eu) and 10.7 (Am) kcal/mole, while the corresponding $\Delta S\dagger$ values were -6.8 and -12.2 cal/°C/mole. (auth) (UK)

6298 ORGANIC COMPOUNDS OF URANIUM(V): REACTIONS OF URANIUM PENTAETHOXIDE WITH GLYCOLS, THIOACIDS, AND ALKYL THIOGLYCOLATES. Dubey, S.; Bhandari, A. M.; Misra, S. N.; Kapoor, R. N. (Univ. of Jodhpur, India). Indian J. Chem.; 8: 97-102(Jan 1970).

Reactions of uranium pentaethoxide with various glycols (ethane-1,2-diol, propane-1,2-diol, butane-1,4-diol, butane-1,2-diol, butane-2,3-diol, pentane-1,5-diol, pinacol, and hexylene glycol) lead to the formation of the derivatives of the type $U(OEt)_3(O_2R)_2$ and $U(OEt)(O_2R)_3$ and $U(O_2R)_3(O_2RH)$, where $R\langle^{OH}_{OH}$ represents a glycol molecule, in general. Thiolactic and thiosalicylic acids yield the compounds of the type $U(OEt)_3(SRCOO)$, $U(OEt)(SRCOO)_3$, $U_3(SRCOO)_5$ and $U(SRCOO)_2(HSRCOO)$ in almost quantitative yields, whereas thiobenzoic acid gives the derivatives of the type $U(OEt)_4(S \cdot CO \cdot C_6H_5)$, $U(OEt)_3(S \cdot CO \cdot C_6H_5)_2$ and $U(OEt)_2(S \cdot CO \cdot C_6H_5)_3$. The reactions between uranium pentaethoxide and alkyl (methyl, ethyl, and n-butyl) thioglycollates were also investigated. The ethoxy groups of some of the derivatives are replaced by t-butoxy groups on treatment with t-butanol. Molecular weight determination of some of the soluble derivatives in benzene suggests them to be dimeric in boiling benzene. (auth)

6299 MIXED CRYSTALS OF COMPOUNDS WITH THE COMPLEX CATIONS $[UO_2(CO)_4(NH_2)_2H_2O]^{2+}$ AND $[UO_2(CO)_3(NH_2)_2]^{2+}$. Ellert, G. V.; Tsapkina, I. V.; Baranova, L. P. Zh. Neorg. Khim.; 15: 1891-8(Jul 1970). (In Russian).

The reactions of $[UO_24KaH_2O](NO_3)_2$ (I) and $[UO_25Ka](NO_3)_2$ (II), where Ka is $CO(NH_2)_2$, with sodium halides were studied in aqueous and alcohol solutions. In aqueous solutions of compound I, only one nitrate ion is replaced with a halogen ion. Mixed crystals with the composition $[UO_24KaH_2O]X_x \cdot (NO_3)_{2-x}$ (X = I, B; x = 0 to 1) are formed. Under analogous conditions $[UO_24KaH_2O]ClNO_3$ and $[UO_24KaH_2O]Cl_{0.5}(NO_3)_{1.5}$ are formed. In alcohol solutions of Compound I, one iodine ion can replace two nitrate ions, giving $[UO_24KaH_2O]I_2$ and $[UO_24KaH_2O]I_x(NO_3)_{2-x}$ (X = 1.4-2). In Compound II, both in alcohol and aqueous solutions, both nitrate ions can be substituted by iodine ions. The compounds $[UO_25Ka]I_x(NO_3)_{2-x}$ (X = 1.43 to 1.27) and $[UO_25Ka]NO_3Cl$ were formed. (tr-auth)

6300 REACTION OF URANIUM HEXAFLUROIDE WITH TRIFLUOROACETIC ACID. Sadikova, A. T.; Nikolaev, N. S.; Rasskazova, T. A. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 15: 2012-13(Jul 1970). (In Russian).

The behavior of UF_6 in trifluoroacetic acid was considered. Experiments showed that, at first, the hexafluoride dissolves in the acid and forms a weakly colored solution. On standing, green

crystals with the composition $UF_5 \cdot HF$ are isolated. No reaction of uranyl fluoride with trifluoroacetic acid was noted. (tr-auth)

6301 NEW HEXAHALOGENMETALLATES OF RHENIUM AND TECHNETIUM. Muenze, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Phys. Chem. (Leipzig); 239: 31-2(1968). (In German).

The hexahalorhenates and hexahalotechnetates were investigated by reduction at controlled cathode potential. (M.C.G.)

6302 REDOX AND HYDROLYSIS REACTIONS OF RHENIUM AND TECHNETIUM COMPOUNDS. PART I. INVESTIGATIONS ON THE ELECTROCHEMICAL PERTECHNETATE REDUCTION IN ALKALINE SOLUTIONS. Muenze, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Phys. Chem. (Leipzig); 238: 364-76(1968). (In German).

The following reactions took place in the cathodic reduction of pertechnetate solutions in various electrolytes: $Tc^{7+} + 2e^- \rightarrow Tc^{5+}$; $Tc^{5+} + e^- \rightarrow Tc^{4+}$; $Tc^{4+} + e^- \rightarrow Tc^{3+}$. The processes were identified by determination of the polarographic step heights, adsorption on the electrodes with the help of radioactive indicators, reduction at controlled electrode potentials, as well as impedance measurements. (tr-auth)

6303 U(IV)–U(VI) HYDROLYTIC PRECIPITATE. Baran, Vaclav (Nuclear Research Inst., Rez, Czech.). Inorg. Nucl. Chem. Lett.; 6: 651-5(Jul 1970).

Samples were prepared by an ammonia precipitation of chloride or perchlorate solutions containing various concentrations of U^{4+} and UO_2^{2+} ions, the individualities of which as hydrated cations were proved using absorption spectroscopy. The concentrations of these ions were determined analytically (UO_2^{2+} was determined polarographically, U^{4+} as a difference from U_{total}) after dissolving the precipitate in an acid. The apparent U valence state in a sample was expressed as its U(VI) percentage content. In addition to chemical analysis, infrared and proton magnetic resonance spectra, as well as magnetic susceptibility, were measured. All operations were performed in the absence of air because the samples, especially those with a low U(VI) content, were sensitive to oxidation. (auth) (UK)

Isotope Effects and Exchange

Refer also to abstracts 6361–6363.

6304 (N-70-33049) ISOTOPE EFFECT IN β ZIRCONIUM. Graham, Donald; Hanes, Earl R. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jul 1970. 22p. NTIS.

The isotope effect was determined for ^{89}Zr and ^{95}Zr in beta-zirconium. The migration rate was independent of the tracer mass within experimental error at 942, 1186, 1784, and 1815°C. The maximum value of diffusion coefficient ratio D_{89}/D_{95} is 1.002 ± 0.005. An anneal at 1750°C for 8 hours immediately followed by the deposition and diffusion of ^{95}Nb in the beta phase at 1025°C resulted in a threefold reduction of the diffusion coefficient over that measured conventionally by depositing the tracer at room temperature in the alpha phase. (STAR)

6305 ISOTOPE EFFECT IN GAS TRANSPORT. I. MEASUREMENT OF THE FREE VOLUME ELEMENT IN FOUR POLYMERS ABOVE THE GLASS TRANSITION TEMPERATURE. Ziegel, K. D.; Eirich, F. R. (Polytechnic Inst. of Brooklyn). J. Polym. Sci., Part A-2; 8: 2015-27(Nov 1970).

The experimental observation of an isotope effect in diffusive gas transport across polymeric films is reported. The differences in energies of transport between hydrogen and deuterium were used to estimate the effective dimensions of characteristic minima or "wells" in the potential energy surface of rubbery polymers. The size of a well, determined by assuming it to be a cubical cavity, is interpreted as the effective free volume element v_f, as measured by the hydrogen molecule probe. Estimations were made of the entropy of activation and "jump distance" for the hydrogen diffusion process based on v_f values and experimentally determined pre-exponential factors. Polymers used for the study were: polyurethane, poly (ethyl methacrylate), poly-cis-isoprene, and polydimethylsiloxane. (auth)

6306 NATURE OF ADSORBED PROPYLENE ON ZINC OXIDE. I. FORMATION OF π-ALLYL SPECIES. Dent, A. L.; Kokes, R. J. (Johns Hopkins Univ., Baltimore). J. Amer. Chem. Soc.; 92: 6709-18(18 Nov 1970).

The infrared spectrum of chemisorbed propylene on zinc oxide was studied with six isotopically different propylenes: $CH_3-CH=CH_2$, $CD_3-CH=CH_2$, $CH_3-CD=CH_2$, $CH_3-CH=CD_2$, $CD_3-CH=CD_2$, and $CD_3-CD=CD_2$. Adsorption yielded not only a hydrocarbon spectrum but also an OH (or OD) species. Analysis of the spectrum showed that the hydrocarbon moiety formed on adsorption is an allylic species and that there is strong interaction of the double bond with the surface. Further analysis, based on the assumption that the allylic species has its geometry fixed by the surface bond but behaves as a vibrationally independent system, offered support for the view that adsorbed propylene is a species analogous to the π-allyl ligand of transition metal complexes. (auth)

6307 NATURE OF ADSORBED PROPYLENE ON ZINC OXIDE. II. REACTIONS OF π-ALLYL SPECIES. Dent, A. L.; Kokes, R. J. (Johns Hopkins Univ., Baltimore). J. Amer. Chem. Soc.; 92: 6718-23(18 Nov 1970).

The reaction over zinc oxide of propylenes (labeled and unlabeled) in the presence and absence of deuterium was studied both by traditional mechanistic and infrared techniques. Isomerization of labeled propylene (intramolecular hydrogen exchange) and intermolecular hydrogen exchange occurred at roughly comparable rates. Furthermore, propylene–deuterium change occurred at a rate competitive with the additional reaction and the product contained a distribution of deuteriopropanes. Comparison of these results with those obtained for ethylene led to the conclusion that those reactions that occur only with propylene are a consequence of the formation of reactive π-allyl species. (auth)

6308 KINETIC STUDIES OF EXCHANGE BETWEEN METALLIC MERCURY AND MERCURY COMPOUNDS IN SOLUTION. III. Marshall, R. A. G.; Pollard, D. R. (Sir John Cass Coll., London). J. Amer. Chem. Soc.; 92: 6723-8(18 Nov 1970).

A new reaction procedure was developed to extend the study of the isotopic exchange of organo-mercury compounds with a metallic mercury surface. This made possible the investigation of the exchange of mercury diphenyl in a series of solvents and in the presence of surfactants. Activation parameters were examined according to Leffler's theory and were interpreted to indicate a difference of solvation between the transition and the ground states. A comparison was also made between the rates of exchange of mercury diphenyl and phenylmercuric chloride with a mercury surface saturated with reactant. Both results confirm the previous postulate that the reaction proceeds via an Sei four-center reaction mechanism. (auth)

6309 MECHANISMS OF ELIMINATION REACTIONS. XVI. STEREOCHEMISTRY OF ELIMINATION FROM 2- AND 3-HEXYLTRIMETHYLAMMONIUM IONS. AN EXPLANATION OF THE SYN–ANTI DICHOTOMY. Bailey, David S.; Saunders, William H. Jr. (Univ. of Rochester, N. Y.). J. Amer. Chem. Soc.; 92: 6904-10(18 Nov 1970).

Stereospecifically deuterated 3-hexyl-4-d-, 3-hexyl-2-d-, and 2-hexyl-3-d-trimethylammonium iodides were prepared and subjected to elimination reactions under a variety of conditions. The product proportions, deuterium contents of products, and assumed isotope effects were combined to calculate the amount of syn elimination expected in the absence of the deuterium label. Syn elimination is important only in the production of trans-olefin, and increases with increasing strength of the attacking base. Under any given set of conditions, the importance of the syn → trans route increases in the order 2-hexyl → 2-ene < 3-hexyl → 2-ene < 3-hexyl → 3-ene. These results were found to be consistent with a steric theory of syn elimination in which the key assumption is that the bulky trimethylammonio group forces the γ and β' groups on the alkyl chain into conformations where they hinder approach of base to the anti β-hydrogen, thereby raising the energy of the anti → trans above that of the syn → trans route. The range of applicability of the theory is discussed. (auth)

6310 GAS-PHASE RECOMBINATION RATES OF HYDROGEN AND DEUTERIUM ATOMS. Bennett, J. E.; Blackmore, D. R. (Thornton Research Centre, Chester, Eng.). J. Chem. Phys.; 53: 4400-01(1 Dec 1970).

The recombination rate of deuterium atoms in the presence of molecular deuterium and a value at room temperature of the ratio k_{2H}/k_{2D} are reported. The experimental techniques are briefly described. The recombination rate constants for deuterium on a Teflon-coated tube were surface rate constant, 0.17 ± 0.24 sec^{-1} and gas-phase recombination rate $(5.4 \pm 0.7) \times 10^{15}$ cm^6 mol^{-2} sec^{-1} and are both of a magnitude comparable to those found for hydrogen atoms. The ratio of the gas-phase recombination rates k_{2H}/k_{2D} was found to be 0.8 ± 0.2. (B.L.M.)

6311 ASYMMETRIC GRIGNARD AND MEERWEIN–PONNDORF–VERLEY REDUCTIONS. LONG-RANGE ASYMMETRIC SYNTHESIS AND THE REDUCTION OF PERFLUOROALKYL CARBONYL COMPOUNDS. Ridgway, Robert Worrell. Durham, N. H.; Univ. of New Hampshire (1970). 158p. University Microfilms Order No. 70-14,346. Thesis.

Long range asymmetric reductions of representative alkyl phenyl ketones by γ- and δ-asymmetric Grignard reagents prepared from optically active 1-halo-3-phenylbutanes and 1-chloro-4-phenylpentane were studied. The "normal" deuterium isotope effects for these reductions were determined. The stereochemical behavior of the diastereotopic hydrogens transferred from the β-carbon during γ-asymmetric Grignard reductions was studied by means of stereospecifically deuterium labeled reagents. A clear preference for the reaction of one of the hydrogens was detected, and the degree of preference was found to depend upon the particular ketone reduced. A stereochemical model for γ-asymmetric Grignard reductions is discussed which can be used to rationalize the experimentally observed results of these reactions. Trifluoromethyl phenyl ketone was shown to undergo a facile and essentially irreversible Meerwein-Ponndorf-Verley reduction with magnesium alcoholates but not with salts of aluminum, sodium or lithium. This ketone was reduced with a number of chiral alcoholates. The effect of solvent, length of the methylene chain and substituents on the asymmetric center was studied. In all cases tested these alcoholates provided reduction products with appreciable optical activity. The anomalous behavior of perfluoroalkyl carbonyl compounds toward reduction is discussed from the standpoint of mechanism, deuterium isotope effects, and stereochemistry. A nonplanar cyclic transition state model is proposed for asymmetric reductions of these compounds. Widely divergent trends were noted in long range asymmetric reductions by reagents containing aromatic substituents as compared to those containing only saturated substituents. This behavior is discussed in terms of competitive reduction by an equilibrating mixture of intramolecularly complexed and uncomplexed reducing agent. (Diss. Abstr. Int., B)

6312 MOLECULAR MOTIONS OF HYDROGEN HALIDES AND DEUTERIUM HALIDES IN LIQUID SULFUR HEXAFLUORIDE. Huong, P. V.; Couzi, M.; Perrot, M. (CNRS, Talence, France). Chem. Phys. Lett.; 7: 189-90(15 Oct 1970).

Vibration-rotation fine structure was observed in the spectra of solutions of HF, DF, and HCl in liquid SF_6. These spectral features are interpreted in terms of rotational motions of the solutes in solution. (auth)

6313 DETERMINATION OF SITE SYMMETRIES IN CRYSTALLINE METHANE AT LOW TEMPERATURES FROM THE INFRARED SPECTRA OF MIXED ISOTOPIC CRYSTALS. Chapados, C.; Cabana, A. (Univ., Sherbrooke, Quebec). Chem. Phys. Lett.; 7: 191-4(15 Oct 1970).

The infrared spectra of uncoupled CH_4, CHD_3, and CD_4 molecules are shown to be consistent with T or T_d site symmetry in phase II of crystalline CH_4 and CD_4. In phase III of CD_4 the site symmetry is low; it does not contain any threefold or higher axis of symmetry. Acceptable site groups are D_2, C_{2v}, C_2, C_s, and C_1. (auth)

6314 HINDERED ROTATION IN THE GROUND AND EXCITED ELECTRONIC STATES OF o-XYLENE. Ingham, Kenneth C.; Strickler, S. J. (Univ. of Colorado, Boulder). J. Chem. Phys.; 53: 4313-18(1 Dec 1970).

A study has been made of the hot bands in the uv absorption spectrum of ortho-xylene and some deuterated derivatives. It is shown that these hot bands arise from excited levels of torsional vibrations of the methyl groups. The spectrum can be explained fairly well assuming independent oscillators with a barrier to internal rotation of 700 ± 50 cm^{-1} in the ground state and 240 ± 35 cm^{-1} in the excited state. The origin of the barrier and the applicability of the independent oscillator model are also discussed. (auth)

6315 INFRARED SPECTRA AND VIBRATIONAL POTENTIAL FUNCTION OF THE PERPENDICULAR VIBRATIONS OF CHF_3 AND CDF_3. Hoskins, L. C. (Univ. of Alaska, College). J. Chem. Phys.; 53: 4216-19(1 Dec 1970).

Infrared spectra of the perpendicular bands of CHF_3 and CDF_3 were examined at high resolution. The ν_4 band of CHF_3 and the ν_5 band of CDF_3 were resolved and Coriolis constants and band centers determined. The measured band shapes of the ν_6 bands permitted Coriolis constants to be calculated. These data were then used to calculate the E-species force constants of the general harmonic potential function. Normal coordinates were also calculated. (auth)

6316 CONDITIONS AFFECTING CESIUM FIXATION AND SODIUM ENTRAPMENT IN HYDROBIOTITE AND VERMICULITE. Klobe, W. D.; Gast, R. G. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-1-GEN-242. Soil Sci. Soc. Amer., Proc.; 34: 746-50(Sep-Oct 1970).

The effect of residual and added K on Cs fixation was studied, using samples of K-extracted Transvaal, South African hydrobiotite with 66, 60, 23, and <1% K saturations. Fixation was measured by the availability of the cations for rapid isotopic exchange in a well-stirred system. Over 95% of the sorbed Cs was fixed above 1% Cs saturation of the exchange capacity regardless of K levels or whether the K was in the form of residual K in hydrobiotite or K added to the vermiculite prior to addition of the Cs. In contrast, trace levels of Cs (i.e., carrier-free ^{137}Cs) were fixed to a much lesser extent, indicating that it may be more available for plant uptake. X-ray and Na entrapment results indicate that Cs saturations below 40% of the exchange capacity result largely in interstratified Na and Cs-rich layers with little edge collapse. Higher Cs saturations resulted in increased edge collapse and Na entrapment. Formation of interstratified layers vs edge collapse of the particles tends to be associated with smaller and larger particles, respectively. (auth)

6317 ISOTOPE EFFECTS IN AUTOXIDATION. PART 7. GROSS HYDROGEN ISOTOPE EFFECTS IN AUTOXIDATION OF BENZYL ETHER. Weisflog, U.; Krumbiegel, P.; Huebner, H. (Institut fuer Stabile Isotope, Leipzig). Isotopenpraxis; 6: 285-7 (Aug 1970). (In German).

The gross isotope effect caused by substitution of deuterium in autooxidation of benzyl ether was studied. The oxidation rate was determined and effects of deuterium substitutions evaluated for dibenzyl ether, butyl benzyl ether, and tert-butyl benzyl ether. (M.C.G.)

6318 ACID-CATALYSED [$^2H_6$] ETHANOLYSES OF ALKYL ORTHOACETATES: EVIDENCE FOR KETEN DIALKYLACETALS AS INTERMEDIATES. Schroeder, Leland R. (Inst. of Paper Chemistry, Appleton, Wis.). J. Chem. Soc., B: No. 9, 1789-94 (1970).

Nmr analyses of 2,6-dichlorobenzoic acid-catalyzed [$^2H_6$] ethanolyses of 1,1,1-triethoxyethane, 1,1,1-trimethoxyethane, and 2-ethoxy-2-methyl-1,3-dioxolan indicate that in each case the orthoacetyl methyl protons are subject to deuterium exchange. This exchange, however, proceeds much more slowly than the accompanying alkoxy exchange. For 1,1,1-triethoxyethane, deuterium incorporation (47 atoms % at equilibrium) was confirmed by hydrolysis and mass-spectral analysis of the resultant ethyl acetate. A reaction mechanism in which a keten dialkylacetal is formed by elimination of a proton from an intermediate carboxonium ion is suggested to account for the observations. (auth) (UK)

6319 INELASTIC COLLISIONS BETWEEN EXCITED ALKALI ATOMS AND MOLECULES. VII. SENSITIZED FLUORESCENCE AND QUENCHING IN MIXTURES OF RUBIDIUM WITH H_2, HD, D_2, N_2, CH_4, CD_4, C_2H_4, AND C_2H_6. Hrycyshyn, E. S.; Krause, L. (Univ. of Windsor, Ont.). Can. J. Phys.; 48: 2761-8(15 Nov 1970).

$5^2P_{\frac{3}{2}} \rightleftharpoons 5^2P_{\frac{1}{2}}$ mixing and $5^2S_{\frac{1}{2}} \leftarrow 5^2P_{\frac{1}{2}}$, $^2P_{\frac{1}{2}}$ quenching in rubidium, induced in collisions with ground state H_2, HD, D_2, N_2, CH_4, CD_4, C_2H_4, and C_2H_6 molecules, were investigated using methods of sensitized fluorescence. The rubidium vapor mixed with each of the gases was excited in turn by each component of the rubidium resonance doublet, and the resulting fluorescence, emitted at right angles to the direction of the exciting light, was resolved into the two fine-structure components whose intensity ratios were measured in relation to the gas pressure using photon counting techniques. The measurements yielded the following cross sections for the mixing and quenching collisions. For H_2: $Q_{12}(^2P_{\frac{3}{2}} \rightarrow {}^2P_{\frac{1}{2}}) = 11$ Å^2, $Q_{21}(^2P_{\frac{3}{2}} \leftarrow {}^2P_{\frac{1}{2}}) = 15$ Å^2, $Q_{10}(^2S_{\frac{1}{2}} \leftarrow {}^2P_{\frac{1}{2}}) = 6$ Å^2, $Q_{20}(^2S_{\frac{1}{2}} \leftarrow {}^2P_{\frac{3}{2}}) = 3$ Å^2. For HD: $Q_{12} = 18$ Å^2, $Q_{21} = 25$ Å^2, $Q_{10} = 6$ Å^2, $Q_{20} = 5$ Å^2. For D_2: $Q_{12} = 22$ Å^2, $Q_{21} = 30$ Å^2, $Q_{10} = 3$ Å^2, $Q_{20} = 5$ Å^2. For N_2: $Q_{12} = 16$ Å^2, $Q_{21} = 23$ Å^2, $Q_{10} = 58$ Å^2, $Q_{20} = 43$ Å^2. For CH_4: $Q_{12} = 30$ Å^2, $Q_{21} = 42$ Å^2. For CD_4: $Q_{12} = 28$ Å^2, $Q_{21} = 38$ Å^2. For C_2H_4: $Q_{12} = 23$ Å^2, $Q_{21} = 32$ Å^2, $Q_{10} = 139$ Å^2, $Q_{20} = 95$ Å^2. For C_2H_6: $Q_{12} = 57$ Å^2, $Q_{21} = 77$ Å^2. The mixing cross sections agree with theoretical values within an order of magnitude. (auth) (Canada)

6320 REACTION OF LEPIDINE, QUINALDINE, AND 1-METHYLISOQUINOLINE N-OXIDES WITH ACETIC ANHYDRIDE. Tamagaki, S.; Ogino, K.; Kozuka, S.; Oae, S. (Osaka City Univ.). Tetrahedron; 26: 4675-89(Oct 1970).

The mechanism of the reactions of lepidine, quinaldine and 1-methylisoquinoline N-oxides with acetic anhydride has been studied by means of both kinetic and ^{18}O tracer experiments. In all cases, the over-all rate of the reaction is markedly affected both by the change of solvent and by the addition of salts. In the case of lepidine N-oxide, a large kinetic isotope effect, $k_H/k_D = 7.7$ in acetonitrile, suggests that the proton-removal is the rate-determining step. This is also the case for 6-methylquinaldine N-oxide which gives the kinetic isotope effect, $k_H/k_D = 7.4$ (at 30°). In the case of quinaldine N-oxide, however, the kinetic isotope effect is small, $k_H/k_D = 2.0$ (at 30°), while quinaldine N-oxide originally trideuterated loses deuterium during the reaction, depicting that the proton-removal is a reversible step and the succeeding N-

O bond cleavage is the rate-determining step. In the case of 1-methylisoquinoline N-oxide, in which k_H/k_D is 3.5 in dioxan at 30° both proton-removal and N–O bond cleavage are equally important in the energy profile of the reaction. (auth) (UK)

Physical Chemistry

Refer also to abstracts 6390, 6865, 6867, 7482, 7483, and 7485–7487.

6321 (CEA-N-1341, pp 437-88) FUNDAMENTAL STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969–November 1969.

Topics covered include: study of the distribution coefficients of the NH_4^+, H^+, Cs^+, UO_2^{2+}, SO_4^{2-} ions in water–tetrabutylammonium bromide and water–ammonium sulfate systems; dismutation of Np(V) in nitric acid medium; high resolution α spectrometry with surface-barrier semiconductors; dissolution enthalpy of neutral molecules in water–ethanol mixtures; dissolution entropy of polar and nonpolar molecules in water at 4°C; kinetics of the reduction of Am(V) by H_2O_2; study of Am(II); preparation and crystal parameters of curium hydride; program for the calculation of dissociation constants of actinide ions; and measurement of equivalent dose rate of pacemakers under the conditions of use. (France)

6322 (DP-1240) RETENTION OF ^{210}Po BY REFRACTORY OXIDES. Hale, William H. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec 1970. Contract AT(07-2)-1. 27p. Dep. NTIS.

^{210}Po is released from the refractory oxide barium cerate at 800 to 1000°C by a volume diffusion process. $BaCeO_3$ is prepared by reacting CeO_2 with BaO or $Ba(NO_3)_2$ at 700°C, with $BaCO_3$ at 800°C, or with BaO_2 at 530°C. (auth)

6323 (UCRL-19530, pp 238-60) PHOTOELECTRON SPECTROSCOPY. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

Topics covered include: multiplet splitting of metal core electron binding energies; electronic densities of states from x-ray photoelectron spectroscopy; comparison of core-level binding energy shifts in molecules with predictions based on Koopmans' theorem; the "gold 5d bands" in $AuAl_2$ and $AuGa_2$; x-ray photoelectron spectroscopy for research in catalysis; splitting of gold p_x core levels by chemical bonding; x-ray photoelectron spectroscopy of compounds containing carbon; and core-electron binding energies for solid compounds of B, Cr, N, and P. (M.C.G.)

6324 (UCRL-19530, pp 261-9) X-RAY CRYSTALLOGRAPHY. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

Topics covered include: the structure of uranocene, betaine hydrochloride structure, crystal structure of $Ni(B_9C_2H_{11})_2$, crystal structure of $CsCr[B_9C_2H_9(CH_3)_2]_2 \cdot H_2O$, and crystal and molecular structure of $H_9(C_6H_5COCHCOC_6H_5)_3 \cdot H_2O$. (M.C.G.)

6325 (UJV-2467-Ch) SELF-DIFFUSION OF TRACE CONCENTRATIONS OF ^{144}Ce, ^{147}Pm, AND ^{155}Eu IN WATER SOLUTIONS. Kepak, F.; Kriva, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 19p. Dep. NTIS (U. S. Sales Only).

Self-diffusion coefficients of ^{144}Ce, ^{147}Pm, and ^{155}Eu in aqueous solutions were determined as functions of pH at two ionic strengths $\mu = 0.01$ and 0.1. From the values of the self-diffusion coefficients and viscosity the ion and Ce(III), Pm(III), and Eu(III) hydroxide colloid radii were calculated. The values of the self-diffusion coefficients were within $10^{-6} - 10^{-7}$ cm^2/sec. The radii of collodial particles of Ce(III), Pm(III), and Eu(III) hydroxides at $\mu = 0.1$ are 37, 22, and 18 Å, respectively. (auth)

6326 (Y-1738) CHARACTERIZATION OF POLYFURFURYL ALCOHOL RESINS. Schmitt, C. R. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 3 Dec 1970. Contract W-7405-eng-26. 42p. Dep. NTIS.

Various physical and chemical test methods and analyses were investigated and evaluated for their suitability in distinguishing differences in different types and batches of commercial, partially polymerized furfuryl alcohol resins, used in reactor materials. The methods studied included optical and electron microscopy, infrared analysis, water and alcohol film spreadability, thermogravimetric-differential thermal analysis, gel permeation chromatography, centrifugation, ultraviolet fluorescence, halogenation, x-ray radiography, cryogenic x-ray diffraction, and ultrasonic attenuation. Most tests failed to show significant differences in various batches; however, molecular weight, differential thermal analysis, and film spreadability tests showed significant differences. (auth)

6327 NEW COMPLEXES OF URANIUM(V). Selbin, J.; Ahmad, N.; Pribble, M. J. (Louisiana State Univ., Baton Rouge). J. Inorg. Nucl. Chem.; 32: 3249-58(Oct 1970).

Nineteen new uranium complexes, eighteen of which contain the element in the very unusual oxidation state of five, and one of which contains quadrivalent uranium complexed for the first time by an arsenic donor ligand, are reported. The novel uranium(V) compounds include, for the first time, ligands whose donor atoms are nitrogen, phosphorus, arsenic, bismuth, sulfur, selenium, and tellurium. The compounds, all prepared under a strictly inert atmosphere, were characterized by elemental analysis, color, decomposition temperature, magnetic moment, ESR average g value (and signal width), ir spectroscopy and, in part, by NMR and visible, near ir, near uv spectroscopy, and mass spectrometry. (auth) (UK)

6328 CRYSTAL STRUCTURE OF $KNaThF_6$. Brunton, George (Oak Ridge National Lab., Tenn.). Acta Crystallogr., Sect. B; 26: 1185-7(1970).

Crystals of $KNaThF_6$ are hexagonal $P\bar{3}$ with $a_0 = 6.3073$ (2) and $c_0 = 7.8907$ (2) Å. The structure of $KNaThF_6$ is a framework of Na octahedra and K and Th 9-coordinated polyhedra. (auth)

6329 CHELATION OF URANYL IONS BY ADENINE NUCLEOTIDES. IV. NUCLEAR MAGNETIC RESONANCE INVESTIGATIONS, ^1H AND ^{31}P, OF THE URANYL–ADENOSINE 5'-DIPHOSPHATE AND URANYL–ADENOSINE 5'-TRIPHOSPHATE SYSTEMS. Rich, Kenneth E.; Agarwal, Raghunath T.; Feldman, Isaac (Univ. of Rochester, N. Y.). J. Amer. Chem. Soc.; 92: 6818-25(18 Nov 1970). (UR-49-1235).

NMR spectra, ^1H (100 MHz) and ^{31}P (40 MHz), were obtained for uranyl nitrate–adenosine diphosphate (U–ADP) and –adenosine triphosphate (U–ATP) mixtures in D_2O having various stoichiometries and basicities over the pD range ≈7 to 11. The spectra show that from pD 7.7 to 11 an equimolar U–ATP mixture consists of 2:2 sandwich-type (ST) dimeric chelates, in which the ligands are the β and γ phosphoryl groups and the ribose hydroxyls, but from pD 6.8 to 7.3 non-ST chelates, in which the uranium is bound only to the β and γ phosphoryl groups, predominate. About 10% of the complex is in the ST form at pD 7.3 in 1:1, 0.05M U–ATP solution, but none is present in a 1:2 solution with the same pD and uranium concentration. Unlike the U–ATP and uranyl nitrate–adenosine monophosphate (U–AMP) systems, the U–ADP system does not contain 2:2 ST complexes at any pD. Rather, at pD 7.7 only non-ST complexes, in which uranium is chelated by the two phosphoryl groups, exist in 1:1 and 1:2 U–ADP mixtures, but these disproportionate to 4:2 ST chelates and free ADP above pD 7.7. Unlike the behavior of non-ST U–AMP complexes, U–ADP and U–ATP non-ST complexes (adenine) ring-stack to a greater extent than do free nucleotides. The U–ATP complex (non-ST form) dephosphorylates completely to the non-ST U–ADP complex in near-neutral solution within 2 days at 27°, but at higher pD, 9.7, dephosphorylation of U–ATP (ST form) directly to the U–AMP ST complex seems to occur. (auth)

6330 STABILITIES OF SOME MIXED COMPLEXES OF Th(IV). Sathe, R. M.; Mahadevan, N.; Shetty, S. Y. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem.; 6: 755-6 (Dec 1968).

Mixed complexes of Th(IV)–EDTA with ligands such as Tiron, catechol, and chromotropic (CTA), gallic, and protocatechuic acids were investigated potentiometrically. The formation curves reveal that two molecules of Tiron and one each of catechol and CTA get attached to Th–EDTA. The stability constant was calculated as 36.4, which agrees fairly with the literature value. (auth)

6331 OXIDE DISSOLUTION MECHANISMS. I. THE ROLE OF FLUORIDE IN THE THORIA/NITRIC/HYDROFLUORIC ACID SYSTEM. Shying, M. E. (Australian Atomic Energy Commission, Sutherland, New South Wales); Florence, T. M.; Carswell, D. J. J. Inorg. Nucl. Chem.; 32: 3493-3508(Nov 1970).

The dissolution mechanism of thoria in nitric–hydrofluoric acid was investigated and the relationships between dissolution rate and fluoride concentration both in solution and on the thoria surface were determined. An interpretation of these results based on the dissociation of surface hydroxyl groups is used to support two proposed steps of the reaction mechanism. The first is the adsorption of fluoride on to the thoria surface and the second is the reaction of fluoride from solution with these sites prior to desorption. The results showed that studies of dissolution mechanisms of oxides should always be accompanied by measurements of the adsorption of the anions taking part. (auth) (UK)

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6332 PREPARATION AND SPECTRUM OF URANIUM(V) IONS IN AQUEOUS SOLUTIONS. Cohen, Donald (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem.; 32: 3525-30(Nov 1970).

Uranium(V) ions were prepared in concentrated chloride solutions and in aqueous carbonate solutions, and the absorption spectra of the uranium(V) ions in these solutions were measured. (auth) (UK)

6333 LINEWIDTHS OF HCl BROADENED BY H_2, D_2, AND HCN. Toth, Robert A.; Hunt, Robert H.; Plyler, Earle K. (Florida State Univ., Tallahassee). J. Chem. Phys.; 53: 4303-7(1 Dec 1970).

The linewidths in the 1←0 band of HCl broadened by H_2, D_2, and HCN were measured at 297°K with a resolution of 0.02 cm^{-1}. The experimental results are compared with linewidths calculated from Anderson's impact theory as extended by Tsao and Curnutte. The agreement between experiment and theory is good for HCl + D_2 and qualitatively correct for HCl + H_2 provided the small impact-parameter approximation of Fiutak and Van Kranendonk is used. For HCl + HCN, the agreement between experiment and theory is fair. Best-fit values for the quadrupole moments and hard-sphere diameters of HCl, H_2, D_2, and HCN are listed and compared with previous values. (auth)

6334 INTRAMOLECULAR ENERGY TRANSFER AND SENSITIZED LUMINESCENCE IN AN EINSTEINIUM β-DIKETONE CHELATE AND THE LOWER LYING ELECTRONIC ENERGY LEVELS OF Es(III). Nugent, L. J.; Raybarz, R. D.; Werner, G. K.; Friedman, H. A. (Oak Ridge National Lab., Tenn.). Chem. Phys. Lett.; 7: 179-82(15 Oct 1970).

Ultraviolet-light-excited energy transfer and sensitized luminescence were induced in an $^{253}ES^{3+}$ β-diketone chelate. The measurements and calculations show that the first excited (J = 7) energy level in the $5f^{10}$ electronic configuration of Es^{3+} is at 9600 cm^{-1} in aqueous 1M $HClO_4$ solution, and this fixes the Landé parameter $\zeta 5f$(aqueous) for Es^{3+} near +3600 cm^{-1}. (auth)

6335 PREPARATION AND CRYSTAL STRUCTURE OF $NaUO_3$ AND $Na_{11}U_5O_{16}$. Bartram, S. F.; Fryscell, R. E. (General Electric Co., Cincinnati). J. Inorg. Nucl. Chem.; 32: 3701-8(Nov 1970).

The studies described arose from the interest in liquid-cooled nuclear reactors employing oxide fuel; it is important to obtain information on compounds that may form by reaction between the coolant and fuel, and in this connection the Na_2O-UO_3 system was examined. Samples were prepared by reacting mixtures of Na_2CO_3 with UO_3 at various mole ratios in an Ar atmosphere at temperatures ranging from 700 to 1000°C and reaction products were handled so as to prevent any air oxidation. Two distinct ternary compounds were identified by x ray diffraction and chemical analysis, one of these being the already known $NaUO_3$, the crystal structure of which was determined to be othorhombic (a_0 = 5.776, b_0 = 5.910, c_0 = 8.283Å, space group Pbnm, isostructural with $CaTiO_3$). A structural arrangement for this compound is given. The second compound was a complex oxide, first believed to be Na_2UO_4 but x-ray diffraction indicated a cubic cell with a = 9.54Å. The crystal structure was closely related to that of CaO, and the space group was $P4_232$. Structural analysis indicated a composition approximately $Na_{11}U_5O_{16}$(or 11 $Na_2$0.10 UO_{2+x}) and the compound appeared to be well ordered and nearly stoichiometric. The valency considerations of U in these complex compounds are discussed. (UK)

6336 SEPARATION OF OXALATE COMPLEXES AND NEPTUNIUM(V) ETHYLENEDIAMINETETRAACETATES IN THE SOLID STATE. Gel'man, A. D.; Blokhin, V. I.; Bukhtiyarova, T. N.; Krot, N. N. (Inst. Physical Chemistry, Moscow). Zh. Neorg. Khim.; 15: 1899-1904(Jul 1970). (In Russian).

Complex compounds of Np(V) with oxalate and ethyienediaminetetraacetate ions with the compositions $NaNpO_2C_2O_4 \cdot NH_2O$ (N = 1 or 3), $NH_4NpO_2C_2O_4 \cdot 2H_2O$, $KNpO_2C_2O_4 \cdot NH_2O$ (N = 1 or 3), $CsNpO_2C_2O_4 \cdot 3H_2O$, $Co(NH_3)_6\ NpO_2 \cdot (C_2O_4)_2 \cdot 2H_2O$, $Co(NH_3)_6\ NpO_2Y \cdot 3H_2O$, and $(NpO_2)_3H_3Y \cdot 5H_2O$, where Y is EDTA ion, were isolated in the solid state from aqueous solutions and analyzed. Properties of the compounds obtained are described. (tr-auth)

6337 THEORY OF THE TETRAD EFFECT IN THE LANTHANIDE(III) AND ACTINIDE(III) SERIES. Nugent, L. J. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 32: 3485-91(Nov 1970).

An explanation is put forward for the tetrad effect recently observed in the Z, or q, dependence of various physical and chemical properties of some complexes in the lanthanide(III) or actinide (III) series. The effect originates mainly from the quantum mechanical interelectronic repulsion energy of the q electrons in each $4f^q$ or $5f^q$ electronic configuration. It can be described in terms of Racah's parameters of interelectronic replusion E^1 and E^3, and the dependence of the coefficients of these parameters on the quantum numbers L and S for the ground electronic state of each Ln(III) or An(III) ion. Taking typical variations in E^1 or E^3 of about 1 percent between two media in equilibrium, with each containing a particular Ln(III) or An(III) species of interest, it is shown that simple thermodynamic considerations can account for the observations. Contributions to the tetrad effect from electron spin-orbit-interactions are estimated to be possible, but they are not expected to be as significant as the Racah interelectronic repulsions. (auth) (UK)

6338 STABILITY OF BINUCLEAR COMPLEXES. Cannon, R. D. (Univ. of East Anglia, Norwich, Eng.). Nature (London); 228: 644-7(14 Nov 1970).

Binuclear complexes are often postulated as intermediates in reactions between metal ions in aqueous solution, and especially in redox reactions, and a general relationship is proposed by which stabilities of certain types of binuclear complex may be estimated from those of the corresponding mononuclear species. A comparison is made between the proton affinities of metal complexes $MX^{(m-x)+}$ and those of the protonated ligands $HX^{(x-1)-}$. Data for $UO_2^{2+}/H_2PO_4^-$, $UO_2 \cdot PO_4 \cdot H_2^+/H_2PO_4^-$, $UO_2 \cdot PO_4 \cdot H_3^{2+}/H_2PO_4^-$, $UO_2(PO_4)_2 \cdot H/H_2PO_4^-$, $UO_2(PO_4)_2 \cdot H^{4+}/H_2PO_4^-$, $UO_2(PO_4)_2\ H_3^{2+}/H_2PO_4^-$, and $ThSO^{2+}/SO_4^{2-}$ are included. Studies are also reported on the hydroxide complexes of Be, Th, and U. (UK)

6339 STUDY OF THE EMISSION SPECTRA OF SAMARIUM, NEODYMIUM, AND URANIUM BETWEEN 2.3 AND 4.1 μm WITH A GRATING SPECTROMETER. Morillon, C. (Laboratoire Aime Cotton, Orsay, France). Spectrochim. Acta, Part B; 25: 513-38 (Oct 1970). (In French).

A Girard grid spectrometer was equipped for measuring wavelengths of emission lines up to 4.1 μm, the average resolution being 0.15 cm^{-1}. By this means, 370 lines of ^{152}Sm and 470 lines of ^{144}Nd were measured in the range 2.3 to 4.1 μm, and 300 lines of U in the range 2.3 to 3.4 μm. About 20% of these lines were classified. (auth) (UK)

6340 COMPLEX COMPOUNDS WITH SOME HYDROXY ACIDS. X. COMPLEXES OF ZIRCONIUM AND THORIUM WITH GLUCONIC AND SACCHARIC ACIDS. Macarovici, Const. Gh.; Motiu, Emilia; Perte, Eugenia. Stud. Univ. Babes-Bolyai, Ser. Chem.; 15: 15-21(1970). (In French).

Studies were made on the formation of Zr(IV) and Th(IV) complexes with gluconic and saccharic acids by extraction in alkaline media. It was established that the ratio of the complex is 1:1 in all cases. The complexes of Zr and Th with saccharic acid were found to be more stable than complexes with gluconic acid. (tr-auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 6445 and 7851.

6341 (NP-18571) PROGRESS REPORT 1969. Kinell, Per Olof (ed.) (Forskningradens Laboratorium, Studsvik (Sweden)). 1970. 62p. (LF-27). Dep. NTIS (U. S. Sales Only).

A summary is given of the current research projects at the Swedish Research Councils' Laboratory, in close proximity to the materials testing reactor R2 at the research establishment of AB Atomenergi, Studsvik, Nyköping. Physical, chemical, medical, biological and technical applications of high intensity neutron fluxes, short-lived radioactive isotopes and high-intensity radiation sources are reviewed. (Sweden)

6342 (UCRL-19530, pp 309-14) RADIATION CHEMISTRY. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

Topics covered include: radiolytic oxidation of the peptide main chain in dilute aqueous solutions, reconstitution mechanisms in the radiolysis of aqueous biochemical systems, and radiation chemistry of biochemical compounds. (M.C.G.)

6343 SUMMARY OF THE ACTIVITIES OF COMECON WITH REGARD TO THE CONTROL OF RADIOACTIVE MEDICAL PRODUCTS. Ostrovski, D. pp 213-15 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

Radiation Effects

Refer also to abstracts 6400 and 7463.

6344 (ANL-7729) ATTEMPT TO DEMONSTRATE THE EXISTENCE OF CHEMICALLY BOUND NEUTRONS. Fried, Sherman; Friedman, Arnold; Wahlgren, Morris (Argonne National Lab., Ill.). Aug 1970. Contract W-31-109-eng-38. 7p. Dep. NTIS.

T. J. Grant and J. W. Cobble have reported the delayed emission of neutrons from a cooled (4°K) crystal of LiF, which contained trapped electrons and which had been exposed to the neutron beam from a Cockcroft–Walton generator. When the irradiated crystal was removed from the liquid helium cooling bath and allowed to warm up in a neutron counter, approximately two neutrons could be observed per experiment. These neutrons were emitted at a rate corresponding to a half-time in LiF of approximately 30 sec. These experiments suggested that the neutrons from a Cockcroft–Walton generator were somehow bound in the LiF crystal at low temperatures and were released as the crystal became warm. Attempts were made to duplicate these experiments using conditions as nearly identical as possible, even to the extent of using a LiF crystal supplied by Grant and Cobble. No effect such as they describe could be observed. (auth)

6345 (BNWL-SA-3526) TIME RESOLVED EMISSION SPECTROSCOPY OF AROMATIC MOLECULES. West, M. L.; Nichols, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 19 Nov 1970. Contract AT(45-1)-1830. 10p. (CONF-701111-2). Dep. NTIS.

From Electron and Atomic Physics Division Meeting, Seattle, Wash.

Single photon counting techniques were used to study the fluorescence response and time dependence of dilute solutions of benzene in cyclohexane excited by protons and ultraviolet radiation. The emission spectra were identical under the two modes of excitation and corresponded to monomer emission from the first excited singlet state of benzene. However, the decay curves of this singlet state emission were not the same for the two modes of excitation. (M.C.G.)

6346 RADIATION-CHEMICAL PROCESSES IN POLYESTERS OF TEREPHTHALIC ACID. Kro, E.; Petshak, M. (Lodz Polytechnical Inst., Poland). Khim. Vys. Energ.; 4: 246-9(May-Jun 1970). (In Russian).

The action of ^{60}Co γ-radiation on a number of polyesters synthesized from terephthalic acid and glycols was investigated; these glycols had from 2 to 10 methylene groups. An effect of oxygen on the direction of radiation-chemical processes (cross-linking or degradation) was observed, plus an effect of "evenness" of methylene groups on the ratio of yields of these processes. The extent of the protective action of the phenylate group was also determined. (auth)

6347 RADIATION STABILITY OF COPOLYMERS OF BUTYL RUBBER. Dzendzelya, V.; Kro, E. (Lodz Polytechnic Inst., Poland). Khim. Vys. Energ.; 4: 250-4(May-Jun 1970). (In Russian).

The possibility of increasing the radiation stability of vulcanized butyl rubber by radiation grafting of styrene or divinylbenzene (DVB) was studied. It was established that the grafted polystyrene chains do not exert an effect on the rate of rubber chain cleavage. The radiation yield of cleavage of these chains in the copolymer, G_c, is 3.2 ± 0.2, and is equal to the chain cleavage yield in crosslinked rubber. In the copolymer of vulcanizate with divinylbenzene there are "free" vinyl groups which are capable of increasing the extent of polymer crosslinking during the irradiation period. Simultaneously with the crosslinking, degradation of the rubber chains takes place; the yield of this falls off with increase in the vinyl group content of the polymer. (auth)

6348 EPR OF FREE RADICALS IN AN ADAMANTANE MATRIX. I. ALIPHATIC AMINOALKYL RADICALS. Wood, David E.; Lloyd, Roger V. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 53: 3932-42(15 Nov 1970).

Aliphatic aminoalkyl radicals $RR'\dot{C}-NR''R'''$ are found to be produced by x irradiation of aliphatic amines in adamantane. The EPR spectra are isotropic with ~2-G linewidths for radicals with less than eight heavy atoms. Spectral parameters are obtained for 24 of these radicals by computer simulation of the EPR spectra. A nontwisted anti conformation is found for the geometry of the aminoalkyl radicals by comparison of observed hyperfine splitting constants with those calculated by INDO. The radicals have a substantial stabilization from a three-electron π bond between the trigonal carbon and the nitrogen. The spin density on carbon is about ¾. The stability of the radicals with respect to carbon substitution is found to be $H_2\dot{C}NH_2 > RH\dot{C}NH_2 > R_2\dot{C}NH_2$. This ordering, which is the reverse of that found for alkyl radicals, is discussed with respect to the electron withdrawing ability of the substituents. The effects of the substituents on the geometry of the radicals are also discussed. (auth)

6349 NONADIABATIC EFFECTS IN THE INTERNAL ROTATION OF $\cdot CH_2COO^-$ IN IRRADIATED ZINC ACETATE DIHYDRATE. Hayes, Robert G. (Univ. of Notre Dame, Ind.); Steible, Daniel J. Jr.; Tolles, William M.; Hunt, John W. J. Chem. Phys.; 53: 4466-9(15 Dec 1970).

The EPR spectrum of the $\cdot CH_2COO^-$ radical in a single crystal host displays nonadiabatic motional effects. A phenomenological theory is suggested, based on the density matrix of the spin system, and a technique is described for rapid calculation of simulated spectra. (auth)

6350 COMPARISON BETWEEN THE EFFECTS PRODUCED BY ELECTRON BOMBARDMENT AND PARTIAL DISCHARGES ON THIN POLYETHYLENE SAMPLES. Mayoux, Christian; Teisseyre, Yves (Ecole Nationale Superieure d'Electronique, d'Informatique et d'Hydraulique, Toulouse). Compt. Rend., Ser. B.; 271: 665-8(5 Oct 1970). (In French).

Structural changes produced by an electron beam (accelerated between 100 and 3,000 V) or by partial discharges on thin polyethylene samples, were observed using infrared spectrophotometry and multiple reflection techniques. The effects of the two modes of irradiation on the material were compared. (France)

6351 THERMAL DECOMPOSITION STUDIES OF SILVER NITRITE AND SILVER PERMANGANATE. Schneller, John William. Burlington, Vt.; Univ. of Vermont (1969). 178p. University Microfilms Order No. 70-10,732.

Thesis.

The kinetics of the thermal decompositions of both γ-irradiated and unirradiated silver nitrite and silver permanganate were studied in detail. The kinetic data for the thermal decomposition of unirradiated silver permanganate do not fit the Special Prout-Tompkins equation but do fit the ordinary Prout-Tompkins equation. This result casts doubt on the association of the Prout-Tompkins mechanism with data fitting the Prout-Tompkins equation. The data also fit the Avrami-Erofeev equation for index two. This is consistent with the microscopic observations of Oates and Todd. The mechanism of the bulk decomposition of silver permanganate is interpreted in terms of two-dimensional growth of a constant number of active nuclei. The effect of pre-irradiation is to increase the rate of thermal decomposition. This increase is interpreted in terms of an increased number of active nuclei within the bulk of the crystal, the number of nuclei on the surface remaining essentially constant. The decomposition curves for silver nitrite exhibit an extensive linear region from about 15% to 45%. Microscopic observation of single-crystal decompositions showed the reaction followed a contracting envelope mechanism. A contracting envelope equation was derived which fit the kinetic data. The products of the decomposition in vacuo are crystalline silver and nitrogen dioxide. The effect of pre-irradiation on the thermal decomposition of silver nitrite is unique in that this is the first example of a compound which becomes thermally more stable after exposure to cobalt-60 gamma rays. This unusual behavior was carefully studied and a mechanism is proposed to explain it. (Diss. Abstr. Int., B)

6352 ELECTRON SPIN RESONANCE STUDY OF X-IRRADIATED SINGLE CRYSTALS OF DI-n-BUTYL OXALATE–UREA AND DI-n-BUTYL MALONATE–UREA INCLUSION COMPOUNDS. Lai, Allen A.; Birrell, G. Bruce; Griffith, O. Hayes (Univ. of Oregon, Eugene). J. Chem. Phys.; 53: 4399-4400 (1 Dec 1970).

Electron spin resonance studies of x-irradiated single crystals of di-n-butyl oxalate–urea and di-n-butyl malonate–urea inclusion compounds indicated that in the aliphatic esters the dominant radicals are not always produced adjacent to the carboxyl groups. The ESR spectra of the long-lived radicals are shown and explained in detail. The radicals are π-electron radicals and arise from one proton bonded directly to the radical center. The dominant radicals are not related to radicals previously reported for studies on oxalic and malonic acids. (B.L.M.)

6353 ESR SPECTRA OF γ-IRRADIATED ADAMANTANE. Gee, D. R.; Fabes, L.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). Chem. Phys. Lett.; 7: 311-13(15 Oct 1970).

ESR spectra of the 1- and 2-adamantyl radicals are reported in γ-irradiated solid adamantane and their relative stabilities discussed. (auth)

6354 TRANSPORT THROUGH FULLY SWOLLEN POLYMER MEMBRANES. Siegel, Richard David. Bethlehem, Pa.; Lehigh Univ. (1969). 153p. University Microfilms Order No. 70-10,618.

Thesis.

In a study of the effect of the swelling solvent on the permeation of low density polyethylene by tritiated toluene statistical and mathematical analyses showed that, for liquid swollen films, the

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intercept of the linear segment of the concentration-time plot is a small value as compared with the line's slope. Consequently, an error of negligible importance in the permeability related slope, or more fundamentally, in any of the measured penetrant concentrations, has a grossly magnified effect on the value of the time delay as calculated from the intercept. Irradiation of fully swollen low density polyethylene films in a ^{60}Co-γ cell at a rate of 0.85 megarads/hour was followed by vacuum drying of the films and their subsequent reswelling and permeability testing with tritiated toluene. The treatment improved the polyethylene's permeability characteristics from 15% after 1 hr of radiation treatment to about 88% after 24 hr of exposure to the radiation source. Tests with tritiated benzene as the penetrant showed that irradiation of low density polyethylene in toluene increases the membrane permeability 47 to 48% regardless of the permeation medium while irradiation in benzene increases the permeability 19–23%, also irrespective of the permeation solvent. No detectable change in these results with time was observed within the limits of experimental error (approximately 7% at the 95% confidence level) and over the time span (up to 455 hr) of several "aging" tests. Besides pioneering a commercially interesting liquid separation process, these results conform with a hypothesis that irradiation of a polymer in the presence of a given solvent molecule locks in a more uniformly disordered polymeric crystalline matrix—one that is more easily solvated after irradiation than before and one with a set spatial distribution of crystallites that facilitates the passage of molecules as a function of their molecular dimensions and as a function of the molecular dimensions of the irradiation solvent. (Diss. Abstr. Int., B)

Radiation Processes

Refer also to abstracts 6259, 6386, 6387, 6648, 6651, and 6654.

6355 EFFECT OF MIXED n-γ-RADIATION ON BENZENE VAPOR-PHASE RADIATIVE THERMAL OXIDATION WITH MOLECULAR OXYGEN. Yur'ev, Z. N.; Timofeev, V. D.; Borisov, E. A. (All-Union Scientific-Research Inst. of Physical Chemistry, Moscow). Neftekhimiya; 10: 251-5(Mar 1970). (In Russian).

The yield of phenol in the radiative thermal oxidation of benzene by molecular oxygen induced by mixed neutron and γ radiation was studied as a function of nuclear reactor energy. With an energy increase from 3 to 10 MW the phenol concentration increased. The effects of pressure on the formation of phenol was also studied at 1 to 10 atm. An increased yield of phenol was observed with an increased pressure. Oxidation of benzene in the neutron and γ radiation field increased the yield of phenol. The radiochemical yield of phenol varied from 3×10^3 to 1.3 to 10^4 molecules per 10 eV depending on the conditions of the experiment. (tr-auth) (INIS)

6356 METHOD FOR PROMOTING A CHEMICAL REACTION WITH RADIOACTIVE GAS. Kasamatsu, Tomomichi (to Japan Atomic Energy Research Inst.). U. S. Patent 3,531,388. 29 Sep 1970. Priority date 2 Feb 1965, Japan.

Chemical reactions in a liquid medium are promoted by bubbling ^{85}Kr through the medium. The dose rate obtained from the finely dispersed gas is very high. Apparatus for performing the method is disclosed. (Offic. Gaz.)

6357 TWO STAGE RADIATION POLYMERIZATION OF ETHYLENE IN THE PRESENCE OF A CARBON DIOXIDE MEDIUM. Kagiya, Tsutomu; Mitsui, Hiroshi; Machi, Sueo; Hagiwara, Miyuki (to Japan Atomic Energy Research Inst.). U. S. Patent 3,531,389. 29 Sep 1970. Priority date 3 Aug 1966, Japan.

Ethylene is polymerized in a CO_2 medium by irradiation in two stages. The first stage irradiation serves to initiate the polymerization by application of a high dose rate (10^4 to 10^5 R/hr) at a temperature of <60°C. The second stage of irradiation is at a dose rate of 100 to 1000 R/hr and is intended to maintain the growth reaction of the polymer. (B.L.M.)

6358 HYDROPHILIC POLYMER SURFACES VIA RADIATION-CHEMICAL TREATMENTS. Hoffman, A. S.; Berbeco, G. R. (Massachusetts Inst. of Tech., Cambridge). Text. Res. J.; 40: 975-82(Nov 1970).

Nylon film and fabric and polyester film substrates were treated to render their surfaces more hydrophilic. Pre-irradiation in air was followed by treatments in solutions containing acrylic acid, sodium styrene sulfonate, N-methylolacrylamide, polyethylene oxide, and water. The relative effectiveness of the different treatments was estimated by measuring contact angles of water on the polymer film surfaces. A nylon fabric was also radiation-grafted and it exhibited significantly improved stain release under water. (auth)

6359 ION-EXCHANGE MEMBRANES OF RADIATION-GRAFTED COPOLYMERIZED SODIUM STYRENESULFONATE TO FLUORINATED POLYMER FILMS. Kargin, V. A.; Bogdanov, M. E.; Cherneva, E. P. (Inst. of Physical Chemistry, Moscow). Vysokomol. Soedin., Ser. B; 12: 461-2(Jun 1970). (In Russian).

Ion exchange membranes were prepared by radioinduced graft polymerization of sodium styrenesulfonate with fluorinated films. The results showed that with an increase in the degree of grafting of sodium styrenesulfonate to the films there was an increase in ion exchange capacity of the membranes as tested with Na^+ and a decrease in specific electric conductivity. (tr-auth)

6360 POLYMER-DRUG INTERACTED SYSTEMS IN THE PHYSICO-CHEMICAL DESIGN OF PHARMACEUTICAL DOSAGE FORMS. Willis, Carl Raeburn Jr. Lafayette, Ind.; Purdue Univ. (1966). 181p. University Microfilms Order No. 70-10,653. Thesis.

For studies of the application of polymer-drug interacted systems to the design of pharmaceutical dosage forms, selected carboxylic acid-containing polymeric materials were screened for their ability to undergo chemically induced imidization and esterification transformations resulting in insoluble esterified and crosslinked products. Free-radical-initiated polymerization was also studied as a means of producing polymer-drug interacted systems. Entrapment and association of an amine drug base, present during chemically induced polymerization; imidization or esterification of polymeric materials was investigated. Radiation-initiated polymerization and polymer crosslinking in the presence of an amine drug base in aqueous solution and in the solid state were also studied for feasibility. The reaction of amine drug base with polymeric hemi-esters was studied as a means of reducing and controlling drug dissolution by physico-chemical means. Polymer-drug salts containing up to 1.67 parts of drug per one part of polymer were found to be water-soluble. In vitro dissolution and equilibrium dialysis studies showed that the drug availability from the interacted system was comparable to the hydrochloride salt of the drug. In an attempt to reduce solubility rates, salts of the amine drug with hemi-esters were prepared and evaluated. The results of this research indicate potential feasibility of radioinduced polymer crosslinking in the presence of drug without producing substantial drug decomposition, whereas the chemically induced polymer reactions studied did produce excessive drug decomposition. Esterified polymer products of reduced aqueous solubility were prepared which retained reactivity with amine drug base and which suggested a new physicochemical approach to the preparation of drug products of controlled prolonged dissolution properties. (Diss. Abstr. Int., B) (TSS)

6361 KINETICS OF HYDROGEN ISOTOPE EXCHANGE REACTIONS. PART XVIII. ALIPHATIC EXCHANGE INDUCED BY β-RADIATION ON AQUEOUS SOLUTIONS OF ALCOHOLS. Gold, V.; Rolston, J. H. (King's Coll., London). J. Chem. Soc., B; No. 9, 1795-1800(1970).

A pcH-independent β-radiation-induced hydrogen exchange reaction was observed for aqueous solutions of t-butyl alcohol containing greater than 8 Ci/l of tritium as part of the solvent. Repeated gas-chromatographic separations of t-butyl alcohol isolated from these solutions lead to the conclusion that the tritiated species is t-butyl alcohol with tritium in the methyl groups. The amount of exchange is proportional to radiation dose, and increases with increasing concentration of substrate, apparently towards a limiting maximum rate. Comparable exchange reactions are observed with isopropyl alcohol and cyclohexanol. (auth) (UK)

6362 KINETICS OF HYDROGEN ISOTOPE EXCHANGE REACTIONS. PART XIX. EFFECT OF ADDED SOLUTES ON ALIPHATIC TRITIUM EXCHANGE OF t-BUTYL ALCOHOL (2-METHYLPROPAN-2-OL) UNDER THE INFLUENCE OF β-RADIATION, AND RELATED EXPERIMENTS. Gold, V.; Rolston, J. H. (King's Coll., London). J. Chem. Soc., B; No. 9, 1800-7(1970).

The effect of added solutes ($AgClO_4$, $CdSO_4$, $CuSO_4$, $NiSO_4$, and H_2O_2) on the tritium exchange in the methyl groups of t-butyl alcohol is to decrease the exchange rate very sharply, the silver salt having the most pronounced influence. The inhibitors do not totally suppress the exchange. The results suggest that there are two exchange routes the major one of which is susceptible to inhibition by electron scavengers while the minor one is not. As a working hypothesis it is suggested that the major exchange route involves reaction between the hydrated electron and t-butyl alcohol. This results in the formation of a solvated electron containing one molecule of t-butyl alcohol in the cluster of solvent molecules in which the electron is trapped with consequent hydrogen exchange between the molecules of the cluster. The minor route is envisaged as the direct formation of this mixed solvent cluster by the action of radiation. The scavenger effects suggest that the second-order

rate constant for the reaction between t-butyl alcohol and the hydrated electron is ca. 10^8 l mol^{-1} s^{-1}. Since this reaction does not destroy the solvated electron, the high value deduced is not incompatible with the low rate constants obtained for the destruction of the hydrated electron by alcohols from pulse-radiolysis studies. Experiments with chemically generated hydroxyl radicals indicate that hydroxyl radicals are not responsible for initiating the radiation-induced exchange. Most of the results reported refer to partially aerated solutions: degassing increases the amount of exchange obtainable for a given radiation dose. (auth) (UK)

6363 KINETICS OF HYDROGEN ISOTOPE EXCHANGE REACTIONS. PART XX. ALIPHATIC EXCHANGE INDUCED BY γ-RADIATION ON AQUEOUS SOLUTIONS OF t-BUTYL ALCOHOL (2-METHYLPROPAN-2-OL). Rolston, J. H.; Gold, V. (King's Coll., London). J. Chem. Soc., B; No. 9, 1808-11(1970).

The action of γ-radiation from a ^{60}Co source on an aqueous solution of t-butyl alcohol containing tritium results in tritium exchange between the solvent and the methyl groups of the substrate. The same dose of γ-radiation is approximately equally effective as tritium β-radiation. The radiation also results in the formation of acetone. The extent of exchange for a given radiation dose is lower in partially aerated than in degassed solutions. (auth) (UK)

Radiolysis

6364 (NP-18583) THYMINE RADIOLYSIS IN AQUEOUS SOLUTION. Teoule, Robert (Lyon Univ. (France). Faculte des Sciences). 1970. 234p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Radiolysis products formed in nucleic acids irradiated in vivo at small radiation doses were determined. A review of the role of DNA in radiobiology and a brief historical outline of the radiolysis of thymine are followed by a description of the operational methods normally used: chromatographic separation and infrared microspectrometry. The study of the manner of fragmentation of hydrouracil and dihydrothymine derivatives by mass spectrometry is described. The way in which gamma energy is transferred to matter and the part played by the primary species produced by radiolysis of water are then recalled and some results given: determination of the structure and synthesis of new stable substances isolated after irradiation in an aerated medium (hydantoine, acetylurea, pyruvyl-N methyl-N' urea); kinetics of formation of relatively stable substances in aerated solution; determination of the formula and preparation of peroxides intermediate between the stable products and thymine; presentation of a new diagram of thymine degradation in aerated aqueous solution; and kinetics of formation of the principal substances in de-aerated aqueous solution as a function of the radiation dose. (France)

6365 RADIOLYSIS OF PYRIDINE AND PIPERIDINE BY ^{60}Co GAMMA RAYS. Rao, K. Narayana; Ramanan, G. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem.; 6: 444-7 (Aug 1968).

In view of the conflicting yields (G values) of the products obtained in the reaction of pyridine and piperidine with γ rays, these systems were reinvestigated in detail and the yields of the products are: for pyridine, $G_{H_2} = 0.025$; $G_{C_2H_2} = 0.016$; $G_{C_2H_4} = 0.006$ and G(Py. → Bipy.) = 0.45 and G(Py. → Poly.) = 3.8, and for piperidine, $G_{H_2} = 3.69$; $G_{C_2H_4} = 0.15$; $G_{NH_3} = 0.06$ and G(Pip. → Poly.) = 4.50. Probable mechanisms for some of the products were suggested. Pyridine was found to offer protection to the radiolytic decomposition of cyclohexane and piperidine. (auth)

6366 RADIATION CHEMICAL STUDIES WITH CYCLOTRON BEAMS. II. THE RADIOLYSIS OF AN AQUEOUS FERROUS AMMONIUM SULFATE SOLUTION WITH CARBON- AND NITROGEN-ION RADIATIONS. Imamura, Masashi; Matsui, Masao; Karasawa, Takashi (Inst. of Physical and Chemical Research, Yamato, Japan). Bull. Chem. Soc. Jap.; 43: 2745-9(Sep 1970).

The yield of ferric ions in the radiolysis of an aqueous ferrous ammonium sulfate solution was determined in the very high LET (linear energy transfer) range. The radiations used were ions of carbon-12 and nitrogen-14, which were accelerated by means of the IPCR cyclotron and which had energies (E_i) of 31 to 77 MeV for C ions and of 17 to 78 MeV for N ions; the LET ranges for water were 24 to 46 eV/Å and 26 to 85 eV/Å respectively. From the plot of $G(Fe^{3+})E_i$ vs E_i, the value for $G(Fe^{3+})$ at an infinite LET was found to be in the vicinity of 2.9. It was also found that there is a substantial difference in the instantaneous yield (G_i) between the two ion radiations of the same LET; this may be ascribed to the differences in the track structures of the heavy-ion radiations. (auth)

6367 METHANE FORMATION IN THE RADIOLYSIS OF NEOPENTANE AND ISOOCTANE. Iida, Shuichi; Yugeta, Rei; Sato, Shin (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 43: 2758-61(Sep 1970).

The formation of methane and hydrogen in the γ radiolysis of neopentane and isooctane has been studied in the presence of an electron scavenger (N_2O) and/or a radical scavenger (styrene). The G-value of nitrogen from neopentane solutions of nitrous oxide was found to be about twice the sum of the decrease in the G-values of methane and hydrogen. From isooctane solutions, $G(N_2)$ was more than three times the sum of the decrease in $G(H_2)$ and $G(CH_4)$. This can be interpreted on the assumption that a significant part of the neutralization of isooctane ions with electrons induces the fragmentation into C_4-hydrocarbons. It was also found that a part of the methane formed (0.9 G in neopentane and 0.2 G in isooctane) was not produced by the reactions of ions or methylradicals, but by a "molecular" process, probably the decomposition of the highly-excited states. (auth)

6368 IONIC PROCESSES IN THE RADIOLYSIS OF NITROUS OXIDE. THE EFFECT OF ELECTRON SCAVENGER AND RARE GAS SENSITIZATION. Takao, Satoshi; Shida, Shoji (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 43: 2766-71(Sep 1970).

The effects of electron scavenger (SF_6) on the γ radiolysis products of N_2O were examined. The sensitization of N_2O by various rare gases was also measured. In the presence of an electron scavenger, 3.0 for the value of $-\Delta G(-N_2O)$ in good agreement with the value of $G(e^-)$ for N_2O was obtained. In the experiments of Xe or Kr containing small amounts of N_2O, the $G(-N_2O)$ values were nearly equal to the respective $G(e^-)$ values for the rare gases, and the addition of SF_6 to the Xe–N_2O system almost completely inhibited nitrogen formation. The results showed that one electron decomposed just one molecule of N_2O. This fact could not be accounted for by the hitherto assumed mechanism, and a new mechanism involving N_2O^- is proposed for ionic processes in the radiolysis of N_2O. In the N_2O–rare gas mixtures of various compositions, the sensitized yields of N_2O decomposition per 100 eV energy absorbed by rare gases were divided into two groups, e.g., the yields from He. Ne mixtures were about twice as large as those from Ar, Kr, and Xe mixtures. This result is discussed in terms of charge transfer and the Penning ionization. (auth)

6369 RADIOLYSIS OF AQUEOUS SOLUTION OF POTASSIUM PERIODATE. Bhattacharyya, S. N.; Bardhan, D. K. (Saha Inst. of Nuclear Physics, Calcutta). Bull. Chem. Soc. Jap.; 43: 2808-11(Sep 1970).

Aqueous solutions of potassium periodate in neutral medium were irradiated with x rays and with ^{60}Co gamma rays. It was observed that the periodate was reduced only to iodate and no other reduction product was detected. A mechanism for the radio-induced reduction of periodate in aqueous solution is proposed and discussed. The effects of methanol on the course of radiolysis were also studied. (auth)

6370 PULSE RADIOLYSIS STUDIES OF ELECTRON TRANSFER IN AQUEOUS DISULPHIDE SOLUTIONS. Willson, R. L. (Mount Vernon Hospital, Northwood, Eng.). J. Chem. Soc., D; No. 21, 1425-6(11 Nov 1970).

Electron transfer to oxidized lipoate, from the electron adduct of thymine, the carboxylate radical-ion CO_2^-, and the ethanol and propan-2-ol radicals was observed directly by pulse radiolysis. (auth) (UK)

6371 RADIATION CHEMISTRY OF CARBOHYDRATES. XII. EFFECT OF STRUCTURAL FACTORS ON THE PROCESSES OF RADIOLYSIS OF AQUEOUS SOLUTIONS OF METHYL GLYCOSIDES. Kudryatov, L. I.; Livertovskaya, T. Ya.; Voznecenskaya, S. V.; Kovalev, Yu. I.; Sharpatyi, V. A.; Kochetkov, N. K. Zh. Obshch. Khim.; 40: 1133-7(May 1970). (In Russian).

The principles that reflect the relation between the structure of a glycoside molecule and the processes that take place during the irradiation of their aqueous solutions and when the irradiation is discontinued were investigated. α-Methyl-D-glucopyranoside, β-methyl-L-arabinopyranoside, and α-methyl-D-galactopyranoside were chosen as the objects of the investigation. This makes it possible to follow the effect the molecular structure has on the course of the radiolysis, because it was shown earlier with α-methyl-D-glucoside that the effect of radiation is manifested mainly at the C_6 position in the molecule. (auth)

6372 MOESSBAUER SPECTROSCOPY OF RADIOLYTIC AND PHOTOLYTIC EFFECTS ON FERRIC CITRATE. Buchanan, D. N. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Inorg. Nucl. Chem.; 32: 3531-3(Nov 1970).

The effects of radiolysis and photolysis on ferric citrate were studied using Mössbauer spectroscopy. Nonirradiated ferric citrate, $FeC_6H_5O_7 \cdot 5H_2O$, has a well-resolved Fe(III) doublet. After radiolysis or photolysis there is in addition an Fe(II) doublet. Some mechanisms of the transition as well as some applications are discussed. (auth) (UK)

6373 RADIOLYSIS PRODUCTS AS REFERENCE SUBSTANCES IN GAS CHROMATOGRAPHY. Armenante, M.; Santoro, V.; Spadaccini, G. (Univ., Naples). J. Chromatogr.; 52: 227-35(21 Oct 1970).

The possibility of using the many branched hydrocarbons, which are formed by radiolysis of an alkane, as reference substances in qualitative gas chromatographic analyses is suggested. The radiolysis spectra of n-alkanes are discussed in general with the aim of showing the rules for rapid and easy identification of the various products. The heavy parts of the radiolysis spectra of n-heptane and n-octane are described in detail as examples. Simple formulas for an easy and rapid calculation of the boiling point of any heavy radiolysis product are appended. (auth)

6374 PICOSECOND PULSE RADIOLYSIS STUDIES. I. THE SOLVATED ELECTRON IN AQUEOUS AND ALCOHOL SOLUTIONS. Bronskill, M. J.; Wolff, R. K.; Hunt, J. W. (Univ. of Toronto). J. Chem. Phys.; 53: 4201-10(1 Dec 1970).

Observations to the solvated electron in water and the common aliphatic alcohols were made in the time region ~20 to 350 psec. Molar concentrations of acid were used to scavenge e^-_{aq} and $k_{(e^-_{aq}+H^+_{aq})}$ was measured as $(1.2 \pm 0.2) \times 10^{10}$ liter/mole · sec for $[H^+_{aq}]$ from 0.5 to 5.0M. The factors limiting the time response of our picosecond pulse radiolysis system are discussed. The time of formation of e^-_{sol} is estimated to be less than 10 psec for all solvents studied. The yield of solvated electrons in alcohols was measured to be approximately one-third of the yield in water at picosecond times. (auth)

6375 RADIOLYSIS STUDIES OF NUCLEIC ACID DERIVATIVES. Greenstock, Clive Lewis. Toronto; Univ. of Toronto (1968).

Thesis.

A study of the effects of radiation on nucleic acid derivatives was undertaken in an attempt to understand the chemical basis for the processes of radioinduced damage. These investigations utilized two different techniques. The first technique, pulse radiolysis, enables one to study the fast chemical reactions between various transient species in dilute solution. In the second technique, the yields of stable radiation damage products are correlated with the reactivities towards primary species attack of the nucleic acid derivatives. By following, by optical means, the rapid decay of e^-_{aq} or ·OH in solution, by following the loss of solute or by monitoring the buildup of a competitive solute, their reaction rates with nucleic acid derivatives have been obtained as a function of pH. The presence of a negative charge on the pyrimidine derivatives at high pH values was found to give a two fold protection against e^-_{aq} attack as was predicted theoretically. It was also found that at pH values above the pK_a further protection against e^-_{aq} attack occurred due to the tautomeric shift from the keto to enol species. Protection was also achieved in long chain polynucleotides by virtue of the screening effect of neighboring bases. The ·OH reaction rates are not influenced by the negative charge on the pyrimidine ring or the keto to enol tautomerization. The site of attack of e^-_{aq} on pyrimidines appears to be at the carbonyl groups whereas in purines the imidazole ring appears to be the most reactive site. For ·OH attack, the reactive site in pyrimidines appears to be the 5,6 double bond. Some spectra believed to be due to the transient species formed as a result of e^-_{aq} and ·OH attack were detected by pulse radiolysis. The yields of stable products formed from the reactions of these transient chemical species are a measure of the radiosensitivity of the nucleic acid derivatives. These stable products formed under various irradiation conditions were isolated and analyzed by thin-layer chromatography. Oxygen was found to at least double the yield of radiation damage in uracil; the four principal products being tentatively identified as 6 hydroxy–5 hydroperoxide, cis and trans uracil glycol and uracil hydrate. The radiolysis of deoxygenated uracil is more complex producing at least 8 stable products of which dihydrouracil, cis and trans uracil glycol, and isobarbituric acid were tentatively identified. A reaction mechanism is proposed for the action of radiation on uracil in dilute solution, which is consistent with the findings of both the pulse radiolysis and product analysis studies. (Diss. Abstr. Int., B)

6376 PICOSECOND PULSE RADIOLYSIS STUDIES. II. REACTIONS OF ELECTRONS WITH CONCENTRATED SCAVENGERS. Wolff, R. K.; Bronskill, M. J.; Hunt, J. W. (Univ. of Toronto). J. Chem. Phys.; 53: 4211-15(1 Dec 1970).

The decay of solvated electrons in various aqueous solutions was studied using a stroboscopic pulse radiolysis technique with a time resolution of 24 psec. High concentrations of solutes such as H_2O_2, acetone, $CdCl_2$, $NaNO_2$, and $NaNO_3$ decreased the initial solvated electron yield, while high acid concentrations did not. Reasons for this reduction in yield are discussed, and the conclusion reached is that the scavengers must be reacting with a precursor to the solvated electron. This precursor is probably a low-energy electron, which reacts prior to solvation. (auth)

6377 RADIATION CHEMISTRY OF GLASSY n-PROPANOL. Dainton, F. S.; Salmon, G. A.; Zucker, U. F. (Univ. of Leeds, Eng. Cookridge Hospital, Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A; 320: 1-22(24 Nov 1970).

The irradiation of glassy n-propanol at 77°K with ^{60}Co γ-rays was investigated by the use of low-temperature optical and esr spectroscopy to identify intermediates and gas chromatography to measure yields of gaseous products. Trapped electrons (e^-_t) are formed with a yield $G(e^-_t) = 1.7 \pm 0.2$. Controlled warming and illumination with light $\lambda > \lambda_{max}$ suggest that electrons are initially immobilized in cavities surrounded by a non-equilibrium configuration of solvent molecules. The decay of e^-_t at 100 to 110 K is first-order, the Arrhenius parameters being lg A $(s^{-1}) = 12.5 \pm 1.5$ and $E_a = 31.3 \pm 2.9$ kJ/mol. For photobleaching with light λ 509 nm, $(\phi\epsilon)_{509} = 460 \pm 501$ $mol^{-1}\ cm^{-1}$ independent of the fraction of e^-_t bleached. Unlike thermal bleaching, photobleaching does not change the total radical concentration as observed by esr. The thermal decay of the uv absorption after complete photobleaching of e^-_t showed evidence of a species stable at 120°K but which decayed slowly at room temperature. An assignment of the uv absorptions to the species EtĊHOH and EtCHO$^-$ is discussed. Some results are presented on the photolysis of γ-irradiated glasses with light of λ 254 nm. (auth) (UK)

6378 EFFECT OF TEMPERATURE ON HYDROGEN ATOM SCAVENGING BY ETHYLENE IN THE γ-RADIOLYSIS OF LIQUID CYCLOPENTANE. Kennedy, M. G.; Stone, J. A. (Queen's Univ., Kingston, Ont.). J. Chem. Soc., D; No. 22, 1478-9(25 Nov 1970).

The relative rate of addition to ethylene compared with H-atom abstraction from cyclopentane for H-atoms produced by the γ-radiolysis of liquid cyclopentane is markedly dependent on temperature. (auth) (UK)

Radioisotope Production

Refer also to abstracts 6322 and 6474.

6379 (DUN-SA-145) ^{128}Xe PRODUCTION PROCESS DEVELOPMENT. Haase, D. W. (Douglas United Nuclear, Inc., Richland, Wash.). 23 Oct 1970. Contract AT(45-1)-1857. 19p. (CONF-701102-2). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

A process for producing the stable isotope, xenon-128, was developed and demonstrated by Douglas United Nuclear, Inc. Neutron irradiation of elemental iodine produces ^{128}Xe, which is separated and recovered in a vacuum system utilizing cryogenic techniques. Approximately 212 standard milliliters of ^{128}Xe were produced from 450 grams of iodine irradiated to a neutron fluence of 5.4×10^{20} n/cm^2. Purity of the ^{128}Xe gas is 99.8%. (auth)

6380 PURIFICATION OF CYCLOTRON-PRODUCED CARRIER FREE ^{139}Ce. Neirinckx, R. D. (South African Council for Scientific and Industrial Research, Pretoria). Int. J. Appl. Radiat. Isotop.: 21: 681-2(Nov 1970).

The irradiation of natural lanthanum foil in the internal deuteron beam of a cyclotron to produce ^{139}Ce by the reaction $^{139}La(d,2n)$ ^{139}Ce is considered and methods for the extraction of the cerium produced discussed. Purification of cerium from lanthanum by liquid extraction, based on the high distribution constant for cerium between nitric acid and bis-(2-ethylhexyl) phosphate (DEHPA) is described and its advantages over other extraction methods considered. (UK)

6381 POLUCHENIE TRANSURANOVYKH I AKTINOIDNYKH ELEMENTOV PRI NEITRONNOM OBLUCHENII. (Production of Transuranium and Actinide Elements by Neutron Irradiation). Krivokhatskii, A. S.; Romanov, Yu. F. Moscow; Atomizdat (1970). 320p.

The process of formation of isotopes on irradiation of actinide elements by neutrons are discussed along with results of calculations of accumulations of actinides in reactors. Experimental data are presented on the yield and composition of these elements formed in reactors and nuclear explosions. Information is presented on isotopes, cross sections, fission products, and uses of the elements. (tr-auth)

6382 RADIOISOTOPE DIRECTORY 1971. Nucl. News.; 13: 54p.(Dec 1970).

Recoil Production and Reactions

Refer also to abstract 7484.

6383 THERMAL ANNEALING BEHAVIOR OF ^{80}Br RECOILS PRODUCED BY THE NUCLEAR ISOMERIC TRANSITIONS IN ALKALI METAL BROMATES. Sasaki, Teikichi; Shiokawa, Takanobu (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 43: 2835-9(Sep 1970).

The transient annealing behavior of bromine recoils produced by isomeric transition was studied in five alkali metal bromates. In the case of ^{80m}Br-labeled potassium bromate, the isothermal annealing curves were characterized by maximum and minimum points. A numerical treatment of them indicated that, at the earlier stage of the thermal treatment, the annealing processes proceeded very fast, which was ascribed to the characteristics of the isomeric transition recoils. A remarkable effect of the cationic components on the thermal annealing was observed and interpreted in terms of their ionization potentials. (auth)

Radiochemistry

Refer also to abstracts 6259, 6268–6271, 6276–6279, 6286, and 6383.

6384 ROLE OF THE HOSPITAL RADIOPHARMACY. Quinn III, J. L. (Northwestern Univ. Medical School, Chicago. Chicago Wesley Memorial Hospital). pp 99-109 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

The responsibilities of radiopharmacists in nuclear medicine units are discussed. With the advent of radioisotope generators, the role of the hospital radiopharmacy becomes very important. Current practices in the Chicago Wesley Memorial Hospital are reviewed. (auth)

6385 TESTING PROCEDURES FOR INDIVIDUAL BATCHES OF RADIOPHARMACEUTICALS. Fruehauf, K. (Farbwerke Hoechst AG, Frankfurt am Main). pp 111-13 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

The particle size distribution tests for radioactive gold colloids and albumin particle suspensions are described. Bioassay is considered essential. (auth)

6386 SELF-DECOMPOSITION OF SOME ^{131}I-LABELLED RADIOPHARMACEUTICALS. Galatzeanu, I. (Inst. of Atomic Physics, Bucharest); Cook, G. B. pp 131-52 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

The stability of radioiodinated (^{131}I) Rose Bengal, thyroxine, hippuran, and human serum albumin towards self-radiolysis was investigated by using external gamma irradiations and by checking the radiochemical purity after various periods of storage. (auth)

6387 RADIOCHEMICAL PURITY AND STABILITY OF SOME RADIOPHARMACEUTICALS. Cifka, J. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). pp 153-80 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

A review is presented on the stabilities of sodium salts of o-iodohippuric acid, diatrizoate, diiodofluorescein, Rose Bengal, and oleic acid labeled with ^{131}I, as well as of radioactive chlormerodrin, colloidal radiogold, sodium phosfate, and chromate, as methods for determining the radiochemical purity. (52 references.) (auth)

6388 DEGRADATION OF ^{131}I-HIPPURAN, ^{131}I-LIPIODOL, ^{131}I-ROSE BENGAL, AND ^{198}Au-COLLOIDAL GOLD. Casas Medina, F.; Rebollo Carrido, D. V.; del Val Cob, M. (Junta de Energia Nuclear, Madrid). pp 181-7 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

The control procedures for hippuran, Rose Bengal, and Lipiodol labeled with ^{131}I and for colloidal gold (^{198}Au) are described. Stabilities were examined by determining radiochemical purities after various conservation periods at different temperatures and in the presence or absence of light. (auth)

Separation Processes

Refer also to abstracts 6259, 6267, 6278, 6290, 6292, 6294, 6445, 6474, 6897, and 8050.

6389 (BNWL-CC-1503) AMERICIUM RECOVERY BY DBBP SOLVENT EXTRACTION PILOT PLANT DEMONSTRATION. Richardson, G. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Feb 1968. Contract AT(45-1)-1830. 18p. Dep. NTIS.

Flowsheets were developed for improving plutonium and americium recovery from the ARHCO Plutonium Reclamation Facility waste by continuous countercurrent solvent extraction. The process employs a solvent containing 30 vol % dibutyl-butyl phosphonate (DBBP) in CCl_4 diluent. Plutonium(IV) extraction is nearly quantitative in this system over a wide range of flowsheet conditions, but americium extraction is highly dependent on the total nitrate salting strength and nitric acid concentration of the aqueous feed. Pilot plant runs made to demonstrate the performance obtainable in pulsed-packed columns with column geometries similar to those proposed for the new ARHCO Waste Treatment Facility are summarized. Only the extraction (WE-1) and americium stripping (S-1) columns were tested. These data extend previously determined results to low nitrate concentration and indicate that at constant pH, the americium E$\mathring{A}$ is proportional to the total nitrate concentration raised to the fourth power. (P.C.H.)

6390 (CEA-N-1341) SEMIANNUAL REPORT OF THE CHEMISTRY DEPARTMENT, NO. 8, JUNE 1969-NOVEMBER 1969. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1970. 533p. (In French). Dep. CFSTI (U. S. Sales Only).

Twelve sections are included; separate abstracts were prepared for 11. The remaining section contains information on miscellaneous chemical studies. (P.C.H.)

For abstracts of individual sections see: 6260, 6321, 6391–6397, 6830, and 6840.

6391 (CEA-N-1341, pp 95-109) TREATMENT OF MEDIUM AND SLIGHTLY ACTIVE EFFLUENTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969-November 1969.

Developments and improvements made in the treatment of radioactive effluents by ion exchange are reported. These include: decontamination of radioactive wastes from nuclear research centers; treatment of water of the storage pools of spent fuel elements; and demineralization of evaporator distillates. The precipitation of radioactive elements was studied by using colloidal precipitates of nickel ferrocyanide. Pulsed-air evaporation was applied to effluent containing traces of solvents (TBP) and a device to stop nonaqueous phases was set up in the recycling circuit. Biodegradable detergents were also studied. A bacterial treatment followed by ozonation proved to be efficient for the decontamination of radioactive laundry wastes. A β–γ installation for semi-industrial tests was constructed. (France)

6392 (CEA-N-1341, pp 111-21) TREATMENT OF URANIUM. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969-November 1969.

Workshop activities and research work were dominated by problems concerned with the conversion of UF_6 into UO_2. A new dry method for manufacturing sinterable UO_2 powder gives good results; based on the hydrolysis of UF_6 by steam followed by a reducing pyrolysis, it led to very satisfactory sintering tests. The production of U_3O_8 standards for emission spectroscopy was developed. (France)

6393 (CEA-N-1341, pp 245-315) STUDY OF AQUEOUS REPROCESSING METHODS: LABORATORY. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

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From Semiannual report of the Chemistry Department, No. 8, June 1969–November 1969.

Uranous oxalate precipitation tests (simulation of tetravalent plutonium oxalate) were performed in order to determine the maximum capacity of a continuous precipitator. Tests were carried out on the dissolution of uranium oxide. Two parameters were changed: composition of the medium, and sectioning method (chopping and sawing). A battery of three large capacity centrifugal extractors was tested in a natural uranium production plant. After hydrodynamic tests, a complete uranium extraction cycle, was investigated. Test on the extractor LX-678 N showed it to possess between 7 and 8 theoretical stages for 8 specified stages. Studies on the Ru decontamination of TBP were carried out and interesting results were obtained by using an aqueous potassium hydroxide–dibutyl phosphate mixture. A uranium–plutonium separation process giving an extremely pure uranium was developed. The use of tridodecylamine in a first extraction cycle performed on natural fuels was tested on a laboratory scale. The direct precipitation of Pu contained in dodecylammonium nitrate was investigated in the homogeneous phase. With the view to the extraction of high specific activity α emitters in the tridodecylamine–alkylbenzene mixture, a study of the α radiolysis of the solvent and diluent was undertaken. First results are reported and a mixer–settler used in hot cells is also described. (France)

6394 (CEA-N-1341, pp 317-35) STUDY OF AQUEOUS PROCESSING: SEMI WASTES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969–November 1969.

A series of decontamination experiments was performed on solutions from the nitric acid dissolution of fuels for testing a centrifuge extractor operating in active atmosphere. The results obtained were satisfactory. The purification of a batch of ^{233}U recovered from irradiated Th was carried out. The process, based on the complexing of Th by hydrofluoric acid and the U saturation of solvent, gave purified U containing 5 to 10 parts of Th per million of U. A method is described for the determination of trace amounts of Th in solutions of ^{233}U by spectrophotometry. Developments in the continued detection of K in gaseous effluents from the dissolution of Al–Pu fuels are described. (France)

6395 (CEA-N-1341, pp 337-61) STUDY OF DRY PROCESS METHODS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969–November 1969.

Halide volatilization tests carried out in the ATTILA facility on enriched uranium-base alloys (U–Al, U–Zr) showed that most of the ^{95}Zr and ^{95}Nb were in oxides produced in pyrohydrolysis of chlorides. Four tests were carried out in the Clovis facility on the reprocessing of UO_2-PuO_2 using the halide volatilization process. The recovery yield of Pu in the form of tetrafluoride was low (80 percent in the last test), but U was recovered with an excellent yield. A study of the reduction of PuF_6 by SO_2 showed that the reduction rate decreased in the presence of UF_6. Decladding tests on Rapsodie pins irradiated to 40,000 $MWdt^{-1}$ by chopping and crushing demonstrated the efficiency of the method. Crushing at high temperature (500°C) in an oxidizing atmosphere was faster than at room temperature and made the decladding of longer sections possible. (France)

6396 (CEA-N-1341, pp 363-84) PREPARATION AND STUDY OF ACTINIDE ELEMENTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969 November 1969.

Research has continued on neptunium separation processes in aqueous solutions from spent fuel processing plants. Np and Pu were separated by extraction using tridodecylammonium nitrate by adding hydrazine to aqueous nitric acid solutions. By making use of the complexing power of sulfuric anions, the Np–Pu separation was obtained from a charged solvent and a reducing solution. The Np–Pu separation by extraction with tridodecylamine in reducing medium was improved by using decanoic acid. The preparation of microspheres of actinide oxides was considered. An experimental study of the stage (extraction of water from the sol leading to the formation of gel droplets) was undertaken and the transfer coefficient in the matter transfer equation was determined. (France)

6397 (CEA-N-1341, pp 385-436) STUDY OF THE VITRIFICATION OF FISSION PRODUCT SOLUTIONS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969–November 1969.

At Marcoule, the vitrification units were set in operation progressively. Studies were made on corrosion of metallic alloys by melting glasses. The productivity of the vitrification pilot plant was improved. The equipment of the hot cell Vulcain is described. A run was carried out in the vitrification pilot PIVER; the activity of solution used was moderate, but sufficient for the facility to be tested technically. The decontamination factors of the gas purification apparatus were determined. It was possible to vitrify a volume of active solution equivalent to 6 to 7 tons of irradiated fuel. (France)

6398 (KFK–893) RECOVERY OF PLUTONIUM FROM FUEL ELEMENT FABRICATION SCRAPS BY EXTRACTION WITH AMINE–CARBON TETRACHLORIDE SOLUTIONS. Koch, G.; Schoen, J.; Franz, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Sep 1970. 33p. (In German). Dep. NTIS (U. S. Sales Only).

The recovery of plutonium from unirradiated fuel fabrication scraps by solvent extraction with amines dissolved in carbon tetrachloride was studied. The processing of UO_2-PuO_2 scraps with low plutonium content (thermal plutonium-recycle fuels, plutonium enrichment about 2%) was of particular interest. The solvents studied were 0.24 M trilaurylamine (TLA) and 0.5 M Amberlite LA-2, respectively, dissolved in carbon tetrachloride. The extraction data required for design of countercurrent flowsheets are presented. Both extraction systems proved to be capable, in principle, of performing the plutonium recovery. The TLA–CCl_4 system shows the better extraction efficiency for plutonium, and higher plutonium/uranium separation factors. However, acids other than nitric acid (e.g., acetic acid) and possibly combined with reducing agents (e.g., ascorbic acid) must be used for the backwash of plutonium. In contrast, dilute nitric acid may be used to backwash the plutonium in the Amberlite-LA-2–CCl_4 system. (auth)

6399 (MLM-1751) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT, APRIL–JUNE 1970. (Mound Lab., Miamisburg, Ohio). 20 Nov 1970. Contract AT-33-3-GEN-53. 21p. Dep. NTIS.

Topics covered include: ^{234}U recovery, ^{229}Th recovery, addition compound of UCl_4 with tetramethylurea, disproportionation of pentavalent Pu, rare earth hydrides, metal oxide microparticles, determination of Hg in oxygen-free Cu, determination of precision of ^{238}Pu data on recovery solutions, γ scanning of high-level ^{238}Pu waste, preparation of Pu-containing solutions for impurity analysis by carrier distillation, and efficiency determination of 30-cm^3 Ge(Li) detector. (M.C.G.)

6400 (ORNL–4618) SOLVENT STABILITY IN NUCLEAR FUEL PROCESSING: CYCLIC IRRADIATION STUDIES OF 15 vol % TBP-n-DODECANE. Moore, J. G.; Crouse, D. J. (Oak Ridge National Lab., Tenn.). Nov 1970. Contract W-7495-eng-26. 24p. Dep. NTIS.

Cyclic irradiation tests were made in which 15 vol % TBP–n-dodecane in contact with 0.38 M $UO_2(NO_3)_2$–3 M HNO_3 was irradiated by a ^{60}Co source for 20, 60, or 120 min (single-cycle radiation doses of 0.3, 1, or 2 Whr/liter). The uranium was then stripped from the organic phase with dilute nitric acid, and the solvent was regenerated by washing with a 0.3 M Na_2CO_3 solution. This cycle was repeated until the solvent had received a total radiation dose of 6 to 10 Whr/liter. Periodically, the solvent was sampled and its extraction and metal retention characteristics were determined. In each test, the phase separation was rapid and clearly defined; there was no evidence of the formation of solids. Exposures at a level of 0.3 Whr $liter^{-1}$ $cycle^{-1}$ had no detectable effect on the solvent performance. At the higher exposures, there was slight retention of uranium by the stripped solvent and an increase in the ability of the solvent to extract zirconium. The zirconium extraction coefficients for solvents irradiated at 1 and 2 Whr $liter^{-1}$ $cycle^{-1}$ were about two and three times, respectively, those obtained with unirradiated solvent. However, the coefficients did not increase with cycling, indicating that the degradation products formed during the irradiation were removed effectively from the solvent by the sodium carbonate wash. Assessment of these results in terms of the solvent exposures that are expected during the processing of 30-day-cooled LMFBR fuels in pulsed columns indicates that process problems arising from irradiation of the solvent will be minimal. (auth)

6401 (STI/PUB-21/39) THORIUM FUEL CYCLE. Bibliographical Series No. 39. (International Atomic Energy Agency, Vienna (Austria)). 1970. 469p. IAEA $13.00.

References (1718) on reactor physics, physical and chemical properties of thorium-bearing fuels, reprocessing of spent fuels, fabrication of fuel elements, and economics are given to journals,

reports, handbooks, conferences, and patents published in English, French, German, Russian, and other languages during the period from the first Thorium Fuel Cycle Symposium in Gatlinburg, Tennessee, held in Dec. 1962 to the middle of 1969. Uranium and thorium reserves, processing of thorium ores, waste disposal, and other problems not typical for the thorium fuel cycle are also included. The references, mainly from NSA, are listed alphabetically by first author and, when no personal or corporate author is given, by title. All non-English titles are translated into English, with the original language indicated in parentheses. Separate author and subject indexes are included. (P.C.H.)

6402 (UCRL-19530, pp 315-28) CHEMICAL ENGINEERING. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

Topics covered include: growth rate of microorganisms as the function of a single limiting substrate, gas-absorption characteristics of agitated aqueous electrolyte solutions, continuous ligand electrochromatography of rare earth ions, foam fractionation of rare earth elements, improved methods for contacting fluid phases in separation processes, mass transfer between fluid phases, cycling zone adsorption, separation of organic liquid mixtures by fractional freezing, and the interface impedance bridge. (M.C.G.)

6403 BEHAVIOR OF SMALL AMOUNTS OF THORIUM IN THE SEPARATION OF HEAVY RARE EARTH ELEMENTS BY ION EXCHANGE. Hagiwara, Zenzi; Terashima, Isao; Koyama, Yoshio (Tohoku Univ., Sendai). J. Inorg. Nucl. Chem.; 32: 3091-9(Sep 1970).

Elutions of the heavy rare earth mixtures involving small amounts of thorium were carried out under various experimental conditions in order to investigate the contamination of the rare earth fractions by thorium. With HEDTA eluants the degree of contamination was reduced with increase in the elution temperature, but the ytterbium and lutetium fractions obtained at 60°C were still contaminated with thorium. On the other hand, with EDTA, the bulk of the rare earth fractions of lutetium and ytterbium obtained in elutions at ordinary temperature was slightly contaminated with thorium, while the fractions obtained at 70°C, for the most part, were free of thorium, due to complete elution of thorium ahead of lutetium. For the removal of 1 or 2 per cent thorium in the heavy rare earth mixture, the EDTA-eluant gave excellent effects, relative to the HEDTA eluant. (auth) (UK)

6404 SEPARATION OF CERIUM FROM AMERICIUM. Proctor, S. G.; Conner, W. V. (Dow Chemical Co., Golden, Colo.). J. Inorg. Nucl. Chem.; 32: 3699-3701(Nov 1970).

A cerium separation procedure was adapted from the work of Zaozerskii and Patkin. These investigators reported the successful separation of cerium from other rare earth elements by ceric peroxide (CeO_3) precipitation at low acidity. This technique was extended to separating cerium from americium in a dilute hydrochloric acid medium. Additional purification from the more common elemental impurities was accomplished by precipitating the americium as an oxalate. Coupling the peroxide and oxalate precipitations provided a rapid procedure for separating gross amounts of cerium from americium and for separating americium from those impurities that do not form insoluble oxalates. Except for cerium, no decontamination from other rare earth elements was accomplished using the peroxide and the oxalate precipitation techniques. (UK)

6405 SOLVENT EXTRACTION USING DIALYSIS THROUGH ARTIFICIAL PHASE BOUNDARIES. Massoumi, A.; Edrissi, M.; Hedrick, C. E. (Atomic Energy Commission, New Brunswick, N. J.). J. Appl. Chem. (London); 20: 357-60(Nov 1970).

Several solvent extraction systems, including uranyl nitrate–saturated potassium nitrate–tri-n-butyl phosphate, were studied using a cellulose dialysis membrane as an artificial phase boundary separating one solvent phase from the other. Solutes were allowed to come to extraction equilibrium by permeation through the membrane. The rate of permeation depended on the osmotic properties of the solute, such as the molecular size and the presence of colloidal species. The extraction equilibrium was established by the solvent extraction properties of the solute in each system, and the equilibrium was approached through the cellulose membrane by a first-order kinetic process. The method appears to be useful for packaging organic solvents in membrane containers to be used for extractions in which time is not a factor. In certain cases, equally well extracted solutes, such as zirconium and aluminum 8-hydroxyquinolates, can be separated because one solute exists as a partially colloidal material [Zr(IV)] and hence does not pass through the membrane rapidly. (auth) (UK)

6406 EFFECT OF TEMPERATURE AND SALT CONCENTRATION ON THE SYNERGETIC EXTRACTION OF URANYL ION. Subramanian, M. S.; Pai, S. A. (Bhabha Atomic Research Centre, Trombay, India). J. Inorg. Nucl. Chem.; 32: 3677-85(Nov 1970).

The effect of temperature on the synergetic extraction of uranyl ion with thenoyl trifluoroacetone (HTTA) and neutral donors was investigated by distribution measurements in the system UO_2–HTTA–S [S = trioctylphosphine oxide (TOPO), tributyl phosphate (TBP), dibenzyl sulfoxide (DBSO) diphenyl sulfoxide (DPSO)] at various temperatures. Results indicate that the distribution coefficient decreases by 20 to 30 percent for a 10°C rise in temperature of the system, whereas it remains virtually the same for extraction by HTTA alone. Values of ΔF, ΔH, and ΔS in the temperature range of 30 to 70°C for the various systems seem to indicate that the greater stability of $UO_2(TTA)_2TOPO$ is derived from the enthalpy and entropy factors. The effect of salt concentration in the aqueous phase on the extraction of the species $UO_2(TTA)_2S$ was also studied by distribution measurements in the above system in the presence of varying concentrations of the perchlorates of lithium, sodium, and ammonium. As expected, the distribution coefficient increased with increase in salt concentration in the aqueous phase. The increased extraction in the presence of lithium perchlorate can be correlated with its larger hydrated ionic radius. (auth) (UK)

6407 AMALGAM METHOD OF SEPARATION OF SAMARIUM FROM IRON. Tikhanina, S. P.; Sayun, M. G. (Ust'-Kamenogorsk Rail-road Inst., USSR. All-Union Scientific-Research Inst. of Mining and Metallurgy of Non-Ferrous Metals, Ust'-Kamenogorsk, USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 13: 615-16(1970). (In Russian).

A method is proposed for purification of samarium from a mixed Sm–Fe amalgam by its decomposition in a sulfate solution with controlled potential. During this decomposition, samarium is quantitatively separated from iron in one operation. At an increase in temperature from 20 to 80°C, the rate of decomposition of the amalgam increased approximately 3 to 4 times. (tr-auth)

6408 METHOD OF DISSOLVING PLUTONIUM-ALUMINIUM ALLOYS. Ganivet, Michel; Girard, Jean; Meniere, Jean-Marie (to Commissariat a l'Energie Atomique). British Patent 1,213,504. 25 Nov 1970. Priority date 4 Sep 1967, France.

The method comprises the steps of treating the alloy in a first vessel with a heated KOH–$NaNO_3$ solution to produce a $KAlO_2$ solution and a PuOH precipitate, filtering the precipitate in a second vessel, washing the precipitate with KOH solution and water, and dissolving the washed precipitate in heated HNO_3 to form a plutonium nitrate solution. An apparatus for carrying out the method is described. (D.L.C.)

6409 GEL CHROMATOGRAPHIC BEHAVIOR OF SOME METAL IONS. Ueno, Yoichiro; Yoza, Norimasa; Ohashi, Shigeru (Kyushu Univ., Fukuoka). J. Chromatogr.; 52: 321-7(21 Oct 1970).

Some metal ions (Na, K, Mg, Ca, Sr, Ba, Mn, Co, Ni, Zn, Cd, and Ca) were chromatographed on Sephadex G-15 columns. Solutions of potassium chloride, sodium sulfate, sodium nitrate, and sodium perchlorate were used as eluting agents, i.e., as background electrolytes. It was found that the elution volumes of the metal ions depend very much on the nature of the background electrolytes employed. These phenomena are explained in terms of the penetrating ability of the background electrolytes into the gel phase and direct and indirect interaction between the metal ions and the gel matrix. (auth)

6410 EFFECT OF SAMPLE CONCENTRATION ON THE GEL CHROMATOGRAPHIC BEHAVIOR OF ALKALINE EARTH METAL IONS ON SEPHADEX COLUMNS. Yoza, Norimasa; Ogata, Takayuki; Ohashi, Shigeru (Kyushu Univ., Fukuoka). J. Chromatogr.; 52: 329-38(21 Oct 1970).

Magnesium, strontium, and barium ions were chromatographed on a Sephadex G-15 column with a 0.1 M sodium chloride solution as an eluent. The shapes of elution curves and K_d values were found dependent on sample concentrations. This was explained in terms of the interaction of the solutes with the gel matrix and the variation in effective sizes of the solutes with the variation in ionic strength of the surrounding medium. The general features of the concentration dependence are discussed on the basis of two representative types of ion, the Mg-type and the Sr- or Ba-type. The former type is influenced by only a negligibly slight adsorption effect over a wide range of sample concentrations, while the latter type is markedly influenced by the adsorption effect, especially at lower sample concentrations. (auth)

6411 AVTOMATICHESKOE UPRAVLENIE TEKHNOLOGICHESKIMI PROTSESSAMI RADIOKHIMICHESKIKH PROIZVODSTV. (Automatic Control of Technological Processes in Radiochemical Industry). Mitskevich, Yu. G.; Bogatova, L. S. Moscow; Atomizdat (1970). 424p.

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Technological processes, apparatus, and schemes used for control in the treatment of irradiated reactor fuels are described. Equations for material and energy balance and for chemical parameters of the extraction processes are analyzed. Algorithms for obtaining transfer functions of the chemical processes are given along with tables of transfer functions for standard chemical reactions. Different methods for the solution of nonlinear equations for extraction process are illustrated. Systems for automatic control of the chemical and extraction processes in the treatment were also studied. (107 references) (tr-auth)

6412 PURITY CRITERIA AND GENERAL SPECIFICATIONS OF RADIOPHARMACEUTICALS. Cohen, Y. (Centre d'Etudes de Saclay, Gif-sur-Yvette, France). pp 1-30 of Analytical Control of Radiopharmaceuticals. Vienna; International Atomic Energy Agency (1970).

From Panel on Analytical Control of Radiopharmaceuticals, Vienna, Austria. See STI/PUB-253; CONF-690725.

A limiting definition of radiopharmaceuticals is given. They are defined as compounds (radionuclides or labeled compounds) intended for administration to human beings for therapeutic or diagnostic purposes. Sealed sources are not considered as radiopharmaceuticals. The useful purity criteria, i.e., radionuclide, radiochemical, and chemical purity, are distinguished and explained. The general methods of quality control are briefly reviewed and their limitations indicated. Various radiopharmaceuticals for different uses are described, including solutions for oral administration and parenteral injection, capsules, and isotope generators. The purity criteria applied will differ, depending on the accuracy of the available production methods and the intended medical use. Specifications laid down by the World Health Organization (WHO) and national pharmacopoeias may vary slightly from country to country without any adverse effect on the users and without the intrinsic quality of the radiopharmaceutical products in question being affected. (auth)

6413 STUDIES ON ISOTOPE SEPARATION OF LITHIUM BY ELECTROMIGRATION IN FUSED LITHIUM BROMIDE AND POTASSIUM BROMIDE MIXTURE. II. COMPOSITION OF SALT IN ANODE COMPARTMENT. Yamamura, Yoshinobu; Suzuki, Shin (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo); 7: 522-6(Oct 1970).

Accurate knowledge on the salt composition in the anode compartment is indispensable when ^6Li is to be highly enriched by electromigration in fused LiBr–KBr mixture. A study was made on the dependence on temperature shown by the salt composition in the anode compartment. Sustained electromigration led to a salt composition in the anode compartment that was determined by the prevailing temperature. The composition was observed for various temperatures between 380 and 740°C: In terms of the ratio Li/K in chemical equivalent, the values were 1.31 at 380°C, 1.29 at 420°C, 1.31 at 460°C, 1.41 at 500°C, 1.76 at 540°C, 1.82 at 580°C, 1.95 at 620°C, 2.16 at 680°C, and 2.34 at 740°C. These results can be explained by assuming that the fused LiBr–KBr mixture is a system composed of two simple salts and their eutectic, and that at temperatures below 550°C, which is the melting point of LiBr, LiBr and KBr are dissolved in fused eutectic, while KBr is dissolved in the fused eutectic and LiBr at temperatures between 550° and 738°C, which latter is the melting point of KBr. (auth)

6414 PROCESS AND APPARATUS FOR THE ENRICHMENT OF ISOTOPIC MIXTURES. (to Societe Nationale des Petroles d'Aquitaine). British Patent 1,211,104. 4 Nov 1970. Priority date 17 Jan 1967, France.

In a process for enriching a mixture of isotopic constitutents in one isotope a stream of the isotopic mixture in gaseous form is introduced into a chamber filled with a sorbing agent that was previously filled with a different gas (a buffering gas) that is inert with respect to the gaseous mixture and the sorbing agent. The gaseous mixture is introduced until at least one fraction (head fraction) has been collected at an outlet from the chamber, and the introduction of gaseous mixture is stopped when the head fraction has been collected. Then the buffering gas is re-introduced and the different fractions of the gaseous effluent displaced by the buffering gas are collected separately at the outlet. The method is particularly applicable to the enrichment of isotopes of B, C, U, or rare gases. The apparatus for carrying out the process is described in detail. (B.L.M.)

6415 CHLORINATION-VOLATILIZATION PROCESSING OF IRRADIATED URANIUM DIOXIDE. I. SORPTION-DESORPTION OF URANIUM CHLORIDES WITH BARIUM CHLORIDE BED. Hirano, Kenmei (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 7: 553-8(Nov 1970).

A chlorination–distillation process for irradiated UO_2 fuel treatment is presented, which utilizes the difference in vapor pressure between the chlorides of uranium and those of fission products. Good recovery of uranium and decontamination of fission products were not obtained with single distillation. Improvement was seen with the adoption of a process in which most of the fission products were removed from the irradiated UO_2 fuel through a sorption–desorption process using a $BaCl_2$ bed. The vapor of uranium chlorides formed by chlorinating UO_2 powder with a mixed gas of Ar and CCl_4 vapor was passed through the bed whose temperature varied along its length from 500° to 100°C, under which conditions the chloride vapor was completely sorbed on the bed. The uranium chlorides thus sorbed did not desorb in a mixed gas stream of Ar and CCl_4 vapor at bed temperatures below 480°C, but when the bed was heated to 480 to 560°C, and Cl_2 gas added to the gas stream, the chlorides were completely desorbed in the form of vapor of higher uranium chlorides. (auth)

6416 SPENT FUEL REPROCESSING. Sousselier, Yves (CEA, Fontenay-aux-Roses, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 50-62(Jul-Aug 1970). (In French). (CONF-700903-6).

From 4th Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden.

The French fuel reprocessing plants (Marcoule, La Hague) and the reprocessing units planned for the new fuels used are presented. The economic benefits of the reliability analysis carried out continuously for the α counters at Marcoule are quoted by way of example. An account is then given of the methods used for low and medium activity effluent treatment, the solidification and the final storage of radioactive wastes. The building of future plants is studied and the effects of reactor technology development on the technical and economic aspects of reprocessing are examined. (France)

6417 THIN-LAYER CHROMATOGRAPHIC BEHAVIOR OF A NUMBER OF METAL IONS ON DEAE-CELLULOSE IN THIOCYANIC ACID-ORGANIC SOLVENT MIXTURES. Oguma, K.; Kuroda, R. (Univ. of Chiba, Japan). J. Chromatogr.; 52: 339-46(21 Oct 1970).

The thin-layer chromatographic behavior of 48 metals was investigated on a weakly basic anion exchanger, DEAE-cellulose, in binary solvent mixtures consisting of HSCN (0.1 to 2.1 M) and an organic solvent such as methanol, acetic acid, acetone, dioxane, etc. For the sake of comparison, the R_F values for the same metals on a microcrystalline cellulose, Avicel SF, in three solvent mixtures involving methanol, acetic acid, and acetone are also presented. The addition of a protic solvent to the aqueous HSCN solution enhances the adsorption of many metals, in so far as the metals form stable thiocyanatocomplexes and their R_F values may be controlled predominantly by the ion-exchange mechanism. This is not the case for the nonprotic acetone–HSCN system, where mechanisms other than ion exchange may prevail to influence the R_F values of the metals. Useful multicomponent separations on DEAE-cellulose are presented to demonstrate the use of R_F measurements for predicting separations in these solvent systems. (auth)

6418 N-BENZYLALKYLAMINES AS EXTRACTANTS OF URANIUM FROM SULFATE SOLUTIONS. Semenov, V. A.; Skorovarov, D. I.; Laskorin, B. N. Zh. Prikl. Khim.; 43: 1544-8(Jul 1970). (In Russian).

Studies on the extraction of U from artificial sulfate solutions of N-benzylalkylamines established that N-benzylalkylamine with normal secondary alkyl radicals are highly effective extractants for uranium in sulfate solutions. N-Benzylalkylamines were found to have definite advantages in comparison with nitrogen and phosphorous organic extractants. The most common benzylalkylamine extractant is the type that can be prepared from aliphatic acids with C_8–C_9. (tr-auth)

6419 DEVELOPMENT OF A METHOD FOR SEPARATION OF RARE EARTH ELEMENTS FROM ALLOYS CONTAINING Fe, Cr, AND Ni. Novakovskaya, E. G.; Denisov, E. I.; Nadezhina, L. S. (Leningrad Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 13: 162-4(1970). (In Russian).

Optimum conditions for the separation of rare earth elements on thorium oxalate collector in the presence of Complexone III are described. The solvent extraction method was used for the separation of rare earths and Th. A method is proposed for the determination of Ce, Eu, La, and Σ rare earth elements in heat-resistant alloys using an oscillopolarograph. (tr-auth)

6420 EXTRACTION OF SCANDIUM, THORIUM, AND ZIRCONIUM BY $C_7H_{15}OP(O)[N(C_2H_5)_2]_2$ FROM SOLUTIONS OF PERCHLORIC ACID IN THE PRESENCE OF THIOCYANATE ION. Litvincheva, A. S.; Fadeeva, V. I.; Alimarin, I. P. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 9, 1935-40 (Sep 1970). (In Russian).

Studies were made on the extraction of Sc, Th, and Zr by the

heptyl ester of tetraethylphosphorodiamidic acid (HEPDA) in benzene in comparison with TBP. The results showed HEPDA in benzene extracts Sc, Th, and Zr from perchloric acid solutions in the presence of thiocyanate ion. Complexes with the composition $Sc(SCN)_3 \cdot 3HEPDA$ (pH 1), $Sc(OH)SCN_2 \cdot 3HEPDA$ (pH 2.5), $Th(SCN)_4 \cdot 2HEPDA$, and $Zr(OH)_2(SCN)_2 \cdot 2HEPDA$ were found in the organic phase. (R.V.J.)

6421 THERMODYNAMICS OF EXTRACTION OF ZIRCONIUM IN THE MONOMERIC STATE FROM NITRATE SOLUTIONS OF TRIBUTYL PHOSPHATE (TBP). Solovkin, A. S. Zh. Neorg. Khim.; 15: 1914-17(Jul 1970). (In Russian).

Literature data on the extraction of zirconium from nitrate solutions by TBP are treated thermodynamically. It is shown that the extraction proceeds with the formation in the organic phase of compounds with the compositions $Zr(NO_3)_4 \cdot 2TBP$, $Zr(OH)(NO_3)_3 \cdot 2TBP$, and $Zr(OH)_2(NO_3)_2 \cdot 2TBP$. Thermodynamic constants for the extraction were calculated and distribution coefficients obtained. (tr-auth)

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EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 6435, 6448, and 7778.

6422 (BNWL–1477) DISPERSION CHARACTERISTICS OF THE COLUMBIA RIVER BETWEEN RIVER MILES 383 AND 355. Sonnichsen, J. C. Jr.; Kottwitz, D. A.; Jaske, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1970. Contract AT(45-1)-2170. 46p. Dep. NTIS.

An analysis was made of the dispersion characteristics of the Columbia River between River Miles 383 and 355. The techniques employed included both remote sensing systems and physical contact sampling systems. Both techniques used dye as a tracer. The effect of effluent buoyancy on the lateral dispersion coefficient is empirically examined. Results indicate that the lateral diffusion coefficient depends upon density differentials. Values for the longitudinal diffusion coefficient generally range between 500 ft^2/sec and 3000 ft^2/sec for flow rates of 80,000 to 130,000 ft^3/sec. (auth)

6423 (CEA-CONF–1538) PROBLEMS ASSOCIATED WITH THE QUANTITATIVE STUDY OF LAKE BALANCE BY MEANS OF THE CONCENTRATIONS OF DEUTERIUM AND ^{18}O IN THE WATER. Merlivat, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 29p. (In French). (CONF-700328–1). Dep. CFSTI (U. S. Sales Only).

From Conference on the Use of Radioisotopes in Hydrology, Vienna, Austria.

The study of the variation of deuterium and ^{18}O in water is used to calculate the balance of reservoirs. In the balance, the positive isotopic terms are known by the analysis of precipitation samples or stream water. The evaporation losses are estimated so that the values of the climatological parameters such as temperature and humidity and the isotopic content of the atmospheric humidity and also the process by which the transfers of water vapor in the atmosphere, are known. The exchanges between the atmosphere and a liquid reservoir are first studied from the isotopic viewpoint. The extent to which the knowledge of the mechanisms implied in the balance schemes plus the experimental data existing for well known natural sites make possible quantitative estimation, is then considered. The comparison of theoretical and experimental data on three lakes shows that the use of the deuterium content gives more accurate results in the case of shallow lakes. (J.S.R.)

6424 (NP–18582) WATER LOAD OF URANIUM, RADIUM, AND GROSS BETA ACTIVITY AT SELECTED GAGING STATIONS, WATER YEAR 1960–61. Mallory, E. C. Jr.; Johnson, J. O.; Scott, R. C. (Geological Survey, Washington, D. C.). 31p. GPO $0.65.

Water samples were collected from 36 rivers during low, medium, and high flows. The drainage areas above the sampling sites represent about 55 percent of continental United States (including 86,000 square miles of Alaska) and 155,000 square miles of Canada. During the 1960 to 61 water year the total uranium-solute load ranged from about 100 pounds contributed by the Nezinscot River to 695,000 pounds contributed by the Mississippi River. The calculated total uranium-solute load of the rivers sampled was used to estimate that about 2 million pounds of uranium were carried in solution from the continental United States to the oceans during this water year. The calculated radium-solute load for the sampling period ranged from about 2.5×10^{-5} pounds for the Nezinscot River to $25{,}000 \times 10^{-5}$ pounds for the Mississippi River. The gross solute load of radium from the conterminous United States to the oceans for water year 1960 to 61 was estimated to be about $67{,}000 \times 10^{-5}$ pounds. (auth)

6425 (RT/PROT–(70)5) COMPOSITION OF CRN TRISAIA SAND AND CLAY AND THEIR ABILITY TO ABSORB SOME FISSION PRODUCTS. Report No. 2. Cassano, G.; Lenzi, G.; Marzocchi, A. (Comitato Nazionale per l'Energia Nuclear, Rome (Italy)). 4 Mar 1970. 30p. (In Italian). Dep. NTIS (U. S. Sales Only).

The mineralogical and grading composition of the CRN Trisaia's sand and its clayey component were studied. Also, the pleistocene based clay was studied by diffractometric and DTA methods. The sand is mainly composed of quartz and plagioclase grains, calcite, with small amounts of heavy minerals (pyroxene and magnetite type). The clay part of the sand, like the underlying clay, is composed of the mineral illite (more or less some impurities constituted of calcite and quartz) with minimum traces of vermiculite. Studies were made of the distribution coefficients for Cs, Sr, Ce, in the sand and clay relating to various parameters e.g., grain size and the presence and concentration of external ions and pH. The cesium sorption from clay is practically influenced only by K^+ at a concentration of 10^{-2} N; on the contrary, strontium is practically influenced by Ca^{++} and Mg^{++}. The pH optimum in the sand that is in the clay is in the range of 4 to 8. (auth)

6426 (TID–25396) USE OF RADIOISOTOPES IN TRACING RESERVOIR LEAKAGE AT ANCHOR DAM. Hansen, Robert L.; Teter, Gerald A. (Bureau of Reclamation, Denver, Colo. Office of Chief Engineer). Jul 1970. 28p. Dep. NTIS.

Radioisotope techniques and equipment were developed to trace the movement of leakage from Anchor Reservoir near Thermopolis, Wyo. Field tests were performed in the summers of 1965, 1966, and 1967. Iodine-131 as NaI was applied in the measurement of ground-water velocity using the single drill hole method. Velocity measurements were made when the reservoir was dry, and results were compared to those obtained when water was impounded behind the dam. Tritiated water was added to the reservoir leakage, and water samples were obtained from drill holes located near the reservoir for analysis of tritium content. Reservoir leakage is through a system of underground caverns which have opened to the surface predominantly at a few discrete areas on the north and northeast sides of the reservoir. Ground-water dissolved oxygen content, tritium tracer experiments, and ground-water level showed that the water cascades into a cavernous system and is carried from the reservoir area in a major escape route, with a relatively small amount being added indirectly to the normal ground-water system. Contribution to the ground-water system causes a temporary water table buildup beneath the reservoir. (auth)

6427 (USGS–474-55) GEOLOGIC STUDIES IN DRY LAKE VALLEY AND HIDDEN VALLEY, SOUTHERN NEVADA. Anderson, R. Ernest; Jenkins, Evan C. (Geological Survey, Denver, Colo.). 1970. 36p. (NTS–176(Rev.1)). Dep. NTIS.

Geologic cross sections of Dry Lake and Hidden Valleys indicate that both areas are underlain by more than 15,000 feet of marine sedimentary strata composed dominantly of clastic rocks in the lowermost part and carbonate rocks in the middle and upper parts. These strata are warped into broad north- to northeast-trending folds that plunge northward in the Hidden Valley area and have a flat-lying axis in the Dry Lake area. The strata have been shifted generally eastward along the northeast-striking Dry Lake thrust beneath Dry Lake Valley. Normal faults that postdate and locally truncate the folds and thrust occur in both areas. They appear to be more numerous in the Dry Lake area, but the largest normal fault, with a throw of about 3,000 feet, occurs along the west flank of the Arrow Canyon Range in the Hidden Valley area. The outlines of the intermountain basins are shown in the cross sections; the Cenozoic materials that fill them are described. Five holes were drilled in Dry Lake and Hidden Valleys. All but Dry Lake 1 bottomed in Paleozoic carbonate rocks. Dry Lake 1 and 2 penetrated 1,500 and 923 feet, respectively, of Muddy Creek Formation. Muddy Creek sediments consist dominantly of very silty to nonsilty clay and minor sandstone, siltstone, gypsum, and limestone. The other three holes were drilled in Hidden Valley through Quaternary alluvium and colluvium to Paleozoic carbonate rocks. Quaternary alluvium and colluvium consist primarily of unconsolidated boulders, gravel, and sand derived from surrounding Paleozoic rocks. (auth)

6428 LITERATURE SURVEY OF THE USE OF RADIOISOTOPES IN GROUND-WATER STUDIES. Mather, J. D. Water Supply Papers of the Institute of Geological Sciences. London; National Environment Research Council (1968). 33p. 10s.

The literature, dealing with radioactive dating of ground water by ^3H, ^{14}C and ^{32}Si dating, was surveyed. In the second part the use of radioisotopes as ground water tracers is reviewed. (UK)

6429 URANIUM, THORIUM, LITHIUM, RUBIDIUM, CESIUM IN THE VOLCANIC ROCKS OF THE KURIL ISLANDS AND KAMCHATKA PENINSULA. Leonova, L. L.; Udal'tsova, N. I. (Inst. of Volcanology, Petropavlosk-Kamchatski, USSR). Geokhimiya; No. 11, 1329–34(Nov 1970). (In Russian).

The distribution of P, Th, Li, Rb, Cs in the recent and Quaternary calc-alkaline rocks of the Kuril Isles and Kamchatka is studied. The values of the average content of these elements and their ratios (Th/U, $U/K \cdot 10^4$, $Th/K \cdot 10^4$, K/Rb) lead to a conclusion that the assimilation process of the sialic matter of the continental crust does not take part in the formation of the calc-alkaline lavas of the Kuril Isles and Kamchatka. The observed differences in the quantities of some elements in rocks are ex-

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plained by the fact of the inhomogeneity of their distribution in the matter of the upper mantle. (auth)

6430 SIZE DISTRIBUTION OF RADIOACTIVE AEROSOLS IN A URANIUM MINE. Chapuis, Alain (Faculte des Sciences, Toulouse); Lopez, Alain; Fontan, Jacques; Billard, Francois; Madelaine, Guy J. J. Aerosol Sci.; 1: 243-53(Aug 1970). (In French).

The size distributions of ions and of neutral radioactive aerosols in a uranium mine were established. In the case of charged particles the size spectrum is obtained by measuring their mobility in an electric field; for neutral particles the coefficient of diffusion was measured. Less than 5% of the total radioactivity is found on small ions; an amount of the same order was found on ultra-fine neutral particles. Theoretical analysis shows that these results are compatible with the dust conditions in the mine. The difference between the present results and those obtained in the United States and Japan may be due to different conditions (humidity and dustiness, for example). Neutral radioactive particles appear to have a size distribution which differs from that of charged particles. Some hypotheses are put forward which might account for this. (auth)

6431 MEASUREMENT OF THE EQUILIBRIUM BETWEEN RADON AND ITS DAUGHTERS IN URANIUM MINES. Lopez, Alain (Faculte des Sciences, Toulouse); Chapuis, Alain; Fontan, Jacques; Billard, Francois; Madelaine, Guy J. J. Aerosol Sci.; 1: 255-64(Aug 1970). (In French).

Two methods are presented for measuring the radioactive equilibrium between radon and its daughter products in French uranium mines. The decay products are collected on a filter and the decrease in α-activity is observed by α-spectrometry using a p-n junction barrier layer cell and with a photomultiplier for the total count. From the decay curves it is possible to calculate the concentrations of RaA, RaB and RaC. Characteristics of the two methods are given and there is a comparison of the results. (auth)

Meteorology

Refer also to abstracts 6274, 6452, 6591, and 6707.

6432 (CEA-R-4093) STUDY OF THE FAR DISTANT DEVELOPMENT OF AIR MASSES LABELED BY A NUCLEAR EXPLOSION AND ENCOUNTERED BY A CONSTANT-LEVEL BALLOON IN THE SOUTH PACIFIC. Doury, Andre (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Nov 1970. 32p. (In French). Dep. NTIS (U. S. Sales Only).

On September 3 and 4, 1968 a chance encounter arose in the South Pacific between a constant-level balloon carrying out solar x ray measurements at 100 mb, and radioactive air masses from a recent nuclear test. The trajectories of the different elements of these air masses having been established over several days and a few orders of magnitude given on the radioactivity levels foreseen, the circumstances of the encounter and the levels and form of the signals transmitted by the balloon are mentioned and an interpretation attempted. The movements of the clouds and the balloon are considered in the three dimensions of space and the uncertainties of position and altitude are discussed. Conclusions are drawn concerning the interest of information provided by constant-level balloons, particular possibilities being to check the calculated trajectories, dimensions and contamination levels of radioactive clouds developing at a great distance. (auth) (France)

6433 CHANGES IN THE NATURAL BETA RADIOACTIVITY OF ATMOSPHERIC AEROSOLS IN THE PLOVDIV IN CONNECTION WITH SOME METEOROLOGIC FACTORS. Stefanova, M.; Genkov, D. (Higher Medical Inst., Plovdiv, Bulgaria). Folia Med. (Plovdiv); 11: 206-13(1969).

The periodic changes of the natural beta radioactivity in Plovdiv for 1966, 1967 and 1968, with some meteorologic factors: velocity and direction of wind, moisture and temperature were investigated. The investigations were implemented by the filter method. The results of the measurements are represented. They show that between the natural beta radioactivity and the temperature the dependence is not clearly expressed. However, the dependence between the natural beta radioactivity on the one hand, and the season, the velocity of wind and moisture on the other, shows a clearly expressed regularity. (auth)

6434 MEASUREMENT OF RADIOACTIVE AEROSOLS. Lekhtmakher, S. O.; Ruzer, L. S. Izmer. Tekh.; No. 12, 66-9 (Dec 1968). (In Russian).

Errors in the measurement of the radioactive aerosol concentration in the atmosphere are analyzed. (tr-auth)

Mineralogy and Exploration

Refer also to abstracts 6289 and 6845.

6435 (RISO-219) GAMMA-RAY LOGGING BY MEANS OF THERMOLUMINESCENCE DOSIMETERS. Nielsen, Bjarne Leth (Geological Survey of Greenland, Copenhagen (Denmark)); Mejdahl, Vagn (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1970. 17p. Dep. NTIS (U. S. Sales Only).

Gamma-ray logging of drill holes by means of thermoluminescence dosimeters offers an interesting alternative to conventional scintillation-detector logging. The feasibility of the method was demonstrated in a preliminary experiment carried out at Kvanefjeld in Greenland. Capsules filled with thermoluminescent $CaSO_4$: Dy were placed at intervals of 10 cm down to a depth of 100 m and exposed for sixteen days after which they were returned to Risö for evaluation. The results were in good agreement with a log diagram obtained by means of a scintillation detector and showed close correlation with core-scanning data. (auth)

6436 URANIUM RESOURCES, PRODUCTION, AND DEMAND. Nucl. Eng. Int.; 15: 932-4(Nov 1970).

The joint report of the ENEA and the IAEA "Uranium Resources, Production and Demand, September 1970", is summarized. Tables are presented showing world uranium production and reserves to 1985, estimated world uranium demand to 1985, and the assumed growth of nuclear generating capacity used to calculate uranium demand. (UK)

6437 IRON IN THE METASOMATIC PROCESS IN THE VICINITY OF ORE VEINS OF URANIUM DEPOSITS. Sokolova, N. T. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya; No. 11, 1335-40(Nov 1970). (In Russian).

In discussions of the ore localization process at the hydrothermal uranium deposits, the pyrite is commonly considered as a main agent of uranium deposition. It is shown that the rocks favorable for the uranium deposition are defined not by the quantity of pyrite in their mineral composition but rather by the presence of such form of iron which could be easily removed in the reaction with uranium-bearing solution and participate in the reduction-oxidation process. This form of iron is commonly represented by the divalent iron bound in the silicate and aluminosilicate fraction of rocks. During the ore localization within the acid rocks the agents of reduction are considered to be inherent in the uranium-bearing solution. (auth)

6438 RADIOMETRICHESKIE I YADERNOGEOFIZICHESKIE METODY POISKOV I RAZVEDKI MESTOROZHDENII POLEZNYKH ISKOPAEMYKH. (Radiometric and Nuclear Geophysical Methods of Prospecting for Ore Deposits). Gorbushina, L. V.; Zimin, D. F.; Serdyukova, A. S. Moscow; Atomizdat (1970). 376p.

Physical and geological methods for quantitative evaluation of geological factors were studied considering the conditions and techniques for each method and the precision of results obtained. Basic data on radioactivity and interactions of ionizing radiation with substances and radioactive elements in nature are discussed. Radiation measurements and equipment used are also discussed. Laboratory methods for analysis of specimens, radiometric methods used in prospecting, and neutron activation are described. Applications of radiometric methods in prospecting and mining of uranium deposits and the protection of personnel against the effects of α-, β-, γ-, and neutron radiation are summarized. 70 references. (R.V.J.)

6439 PERSPECTIVE OF THE URANIUM MARKET. Com. Naz. Energ. Nucl., Notiz.; 16: No. 3, 58-62(Mar 1970). (In Italian).

A resume is given of papers presented at the 1969 Conference of the Atomic Industrial Forum on the future of the uranium market and some evaluations are made of the predictions given. The economics of uranium prospecting is briefly considered. The unencouraging picture of supply is discussed. The economic realities of a future uranium market are emphasized. An outline is given of the international market. The still unprepared policies of the USAEC are discussed. (J.S.R.)

6440 CONCENTRATION AND DISTRIBUTION OF URANIUM IN COEXISTING PEGMATITE FELDSPARS BY THE FISSION TRACK METHOD. Schwarzer, Rudolph Reynolds. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 161p. University Microfilms Order No. 70-11,331.

Thesis.

This study is divided into two parts: the development of a variation of the fission track method of uranium analysis which enables one to estimate the amount of uranium homogeneously distributed

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throughout a mineral phase. This homogeneously distributed uranium is believed to represent the amount of uranium in the mineral lattice and to exclude the uranium present in included phases or along grain boundaries or cracks; and the application of this modified fission track method of uranium analysis to a geologic problem and an evaluation of its usefulness and reproducibility. A study of the concentration and distribution of uranium between coexisting feldspars from some New York State zoned pegmatites lent itself readily to investigation via the fission track method. Thirty-seven coexisting feldspar pairs from seven pegmatites were analyzed for homogeneously distributed uranium. These same feldspar pairs had been analyzed for 16 trace and 3 major elements. The Poisson distribution is used as a model for estimating the amount of homogeneously distributed uranium in the feldspars. The mean value of the Poisson distribution which best fits the observed frequency distribution of fission tracks from a sample is estimated by the ratio of the number of observations of one track/unit area to the number of observations of zero track/unit area. This mean value is an estimate of the fission track density due to uranium in feldspar "lattice sites." The term "lattice site" refers to both substitution of uranium into regular undisturbed lattice sites and substitution of uranium into lattice discontinuities. The concentration of uranium is calculated from the fission track density using the comparative standard method with a soda-lime silicate glass as a standard. Evaluation of the parameters ϕ, R_{eff}, D, and f for both feldspars and standard justify the use of the comparative standard method in its simplest form. The overall average error on a single uranium analysis of a feldspar sample is 31% which is composed of a 15% analytical error and an average sampling error of 27%. The concentration range of homogeneously distributed uranium is 2 to 86 ppb in plagioclase and 1.5 to 58 ppb in K-feldspar. (A little data indicate that the total uranium content of these samples is probably about 2 to 4 times the amount estimated to be uniformly distributed.) The pegmatites studied were placed in a proposed differentiation sequence. The uranium content of both feldspars increases throughout the proposed differentiation sequence. The same effect has been shown for total uranium in other differentiated rock sequences. All the elements analyzed in these feldspars (including uranium) can be classified into three groups on the basis of their behavior pattern throughout the proposed pegmatite sequence: (1) a general increasing concentration, (2) a general decreasing concentration, and (3) an essentially constant concentration. Uranium is classified with those elements which increase in concentration: Na and Pb in plagioclase and Cs, K, and Pb in K-feldspar. Uranium shows significant correlation coefficients with these elements in the respective minerals. R-mode cluster and R-mode ordination analysis duplicate, in an objective manner, the somewhat subjective classification of the elements based on their behavior throughout the proposed pegmatite sequence. The distribution diagram of uranium between coexisting plagioclase and K-feldspar shows the uranium prefers the plagioclase phase. The average uranium K_D (calculated by the reduced major axis method of regression) for the feldspars studied is 0.65 with a correlation coefficient of 0.81. The individual uranium K_D values and the average uranium K_D per pegmatite do not show any regular variation throughout the proposed pegmatite sequence. Thus, the uranium K_D for coexisting feldspars in the pegmatites studied is not a suitable geothermometer. Use of the fission track method in the pegmatite problem studied confirms that it is well suited for analyses of low uranium concentrations, and it presents the investigator with the spatial distribution of uranium which enables him to discriminate between "lattice uranium" and uranium in impurities or inclusions. (Diss. Abstr. Int., B)

Oceanography

Refer also to abstract 6272.

Seismology

Refer also to abstract 6446.

6441 (CEA-R-4091) SEISMIC STUDIES OF NUCLEAR EXPLOSIONS. MEASUREMENT METHODS. Duclaux, Francoise (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Nov 1970. 25p. (In French). Dep. NTIS (U. S. Sales Only).

After reviewing the different methods used in other countries for the seismic studies of underground nuclear explosions, the method employed in the Sahara for fifty km around ground zero is discussed. Comparison of these different methods shows many similarities. The methods used in other countries are noticeable for their size and the importance of the means used. In the Sahara, the technology is characterized by a great concentration of devices for measuring around ground zero. (auth) (France)

6442 (USGS-474-94) EARTHQUAKES, SURFACE FRACTURING, AND STRAIN ASSOCIATED WITH THE CRUET, POD, AND CALABASH UNDERGROUND NUCLEAR EXPLOSIONS AT YUCCA FLAT, NEVADA TEST SITE, OCTOBER 29, 1969. Hamilton, R. M.; Orkild, Paul P.; Dickey, D. D.; Hall, J. C. (National Center for Earthquake Research, Menlo Park, Calif.). 1970. 17p. (NTS-229). Dep. NTIS.

The underground nuclear explosions, Cruet, Pod, and Calabash were detonated October 29, 1969, beneath Yucca Flat at the U.S. Atomic Energy Commission's Nevada Test Site. Twenty seismographs were operated in the immediate area from 70 hours before the first explosion to 45 hours after the last. Twenty-eight shallow earthquakes with magnitudes between −0.2 and 1.8 appear to have been stimulated by the explosions. All but two were within 2 km of an explosion. Two faults near explosion sites showed fracturing at the ground surface. Northwest-trending extensional strains greater than 10^{-6} were measured at the ground surface about 3 km from the Calabash explosion. (auth)

6443 KHARAKTERISTIKI SEISMICHESKIKH VOLN PRI YADERNYKH VZRYVAKH I ZEMLETRYASENIYAKH. (Characteristics of Seismic Waves During Nuclear Explosions and Earthquakes). Pasechnik, I. P. Moscow; Izdatel'stvo Nauka (1970). 192p.

The kinematic and dynamic characteristics of volumetric and surface seismic waves, generated by nuclear explosions in different media were studied. The similarity of kinematic characteristics of waves from explosions and from earthquakes and the differences in their dynamic characteristics were analyzed. Wave peculiarities which can be used to identify recorded seismic data as either explosion-generated or as earthquake-generated are discussed. The level and spectrum composition of microseismic waves in various seismogeological areas were studied, and the problems of selecting the optimum parameters for seismic measuring devices are discussed. The possibility of using data obtained from the explosions for studying the internal structure of the earth is presented. (tr-auth)

6444 NUCLEAR TESTS AND EARTHQUAKES. Robertson, D. S. Nature (London); 228: 693(14 Nov 1970).

Agreement is expressed, in general, with Newstead and Pile (Nature 227: 317 (1970)) that the French nuclear test on May 24th, 1970 was unlikely to have triggered the Peruvian earthquake. The frequent incidence of large earthquakes in Peru is simply a measure of the seismic instability of the region, but nuclear tests adjacent to such regions must remain suspect, however, until proved harmless, and the possibility of a connection between the tests and the Peruvian earthquake cannot be dismissed by statistics applying to other areas. The author does not agree that atmospheric tests are necessarily poorly coupled to the ground, especially when conducted over water, and that time delays are unreasonable; such delays do occur. Detailed analyses for large bomb tests do not appear to be available, but it is in such cases that correlations might be expected to show, if they exist, with regard to underground tests, an important question is whether release of seismic energy in such tests is restricted to the immediate neighbourhood of the source. (UK)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 6441, 6442, 6444, and 6452.

6445 (ORNL-TM-3181) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE): PROGRESS REPORT FOR JULY 1–SEPTEMBER 30, 1970. Arnold, W. D.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). 20 Nov 1970. 18p. Dep. NTIS.

Adding water to the pressure vessel during exposure of oil shale to tritiated hydrogen or tritiated methane decreased the tritium contamination of the shale and of the retorted shale oil slightly. A new bench-scale oil shale retort, designed to simulate a section of a shale chimney, was built and operated successfully. ORNL analyses of a Rulison well head sample for ^{85}Kr and total tritium agreed closely with Lawrence Radiation Laboratory analyses. Continued differences in ORNL and LRL analyses of Gasbuggy samples may be due to changes in tritium distribution caused by tritium exchange during storage. The technique developed for the rapid determination of the total activity of gas samples can be used to increase the sensitivity for measuring low-level ^{85}Kr activity. In tests simulating storage of natural gas in a cavity produced in shale of low permeability, extended contact of methane with shale that was wetted with tritiated water resulted in slight tritium contamination of the methane. Initial attempts to remove the tritium from the tritium-contaminated shale by air purging were not very successful. Fabrication was completed in the ORNL shops of a display model to demonstrate the use of nuclear explosives in copper recovery. (auth)

6446 (UCRL–50867) ANALYSIS OF STRUCTURAL RESPONSE DATA ON BURIED STRUCTURES IN THE NOGGIN AND CREW UNDERGROUND NUCLEAR TESTS. Blake, Alexander; Dow, Jerome P. (California Univ., Livermore. Lawrence Radiation Lab.). 2 Sep 1970. 61p. Dep. NTIS.

Structural response data obtained in two underground nuclear tests, Noggin and Crew are analyzed. At several levels in the emplacement hole for each nuclear device, strain gages, velocity gages, and accelerometers recorded the response of the hole casing and the line-of-sight (LOS) pipe inside it to the ground shock from the nuclear explosion. Vertical velocity gages and accelerometers were also placed at corresponding levels in a nearby satellite hole to measure particle motion in the earth materials. Structural response data from two levels in each emplacement hole—1242 and 985 ft above the shot in Noggin, and 760 and 687 ft above the shot in Crew—were correlated with theoretical response predictions based on a nested cylinder model, using earth motion data from the satellite holes. The agreement is good enough to confirm the suitability of the nested cylinder model as a basis for preliminary LOS pipe design at least with regard to withstanding pressures induced by ground motion. A computer code based on nested cylinders is presented for calculating pressure attenuation factors and making parametric studies on typical nuclear-explosive emplacement systems. (auth)

6447 (UCRL–50929) AIDS FOR ESTIMATING EFFECTS OF UNDERGROUND NUCLEAR EXPLOSIONS. Butkovich, T. R.; Lewis, A. E. (California Univ., Livermore. Lawrence Radiation Lab.). 8 Sep 1970. 114p. Dep. NTIS.

Data and other relationships useful for estimating some of the effects of underground nuclear explosions are assembled and presented in convenient form. Included are charts on: overburden pressure versus depth for various overburden densities; compressional velocity versus overburden density; the relationship between in-situ density, porosity, percent saturation, and wt. % water for various rock grain densities; radius of evaporation versus device yield for various rock densities; cavity volume to depth of burst relationships; peak radius stress as a function of yield and distance from shot point; effects of porosity on chimney configuration; chimney height versus cavity radius relationships; and others. (L.C.L.)

6448 (UCRL–50946) PERMEABILITY OF PICTURED CLIFFS SANDSTONE: GASBUBBY PRESHOT AND POSTSHOT MEASUREMENTS. Quong, R.; La Guardia, V. J. (California Univ., Livermore. Lawrence Radiation Lab.). 7 Oct 1970. 16p. Dep. NTIS.

Specimens of Pictured Cliffs sandstone were recovered from the vicinity (63–116 meters away) of the underground nuclear explosion in Project Gasbuggy. We have measured their matrix permeability, permeability variation with confining pressure, and permeability variation with bedding plane direction. Inherent permeability variation (caused by such properties as porosity and water content) can be adequately distinguished from induced permeability changes by simple models describing gas flow through porous media. Overall we found comparatively little change in permeability of specimens recovered 72 to 116 meters from the explosion point. We did find indications of an onset of increased permeability at distances of 63 to 72 meters. Large-scale cracks and fractures along bedding planes and faults (preexisting or induced) would increase permeability by an indeterminate amount. Except for these conditions, our measurements should be representative of in-situ permeability. (auth)

6449 (UCRL–72568) THE USE OF MULTIPLE EXPLOSIVES FOR NUCLEAR GAS STIMULATION. Nordyke, Milo D. (California Univ., Livermore. Lawrence Radiation Lab.). 10 Nov 1970. 30p. (CONF-701102–3). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

The concept of using multiple nuclear explosives for gas stimulation is analyzed, the results of an economic analysis of a specific situation are summarized, and the problems that must yet be solved are discussed. (auth)

6450 CIVIL ENGINEERING EARTHWORKS AND NUCLEAR EXPLOSIONS. Delort, Francis (Commissariat a l'Energie Atomique, Paris). Ann. Inst. Tech. Batiment Trav. Publics; 23: 93-118(Jul-Aug 1970). (In French).

The mechanical effects of nuclear explosions are described, with a view to their utilization for industrial applications. For the building of canals, it is shown that the distance between charges can be calculated in order to use a minimal total energy. In the case of pin-point applications (harbours, quarries, dams) yields almost equal to a few tens of kilotons would be sufficient to carry out works under difficult environmental conditions. (auth) (France)

Facilities and Equipment

Refer also to abstracts 6844, 6849, and 6905.

6451 (IPP–4/73) HIGH-FIELD MAGNET FOR A HYDROGEN ARC EXPERIMENT. Becker, J. D.; Lohnert, H.; Oswald, B.; Zickert, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr 1970. 33p. (In German). Dep. NTIS (U. S. Sales Only).

The design, construction, and operation of a 120 kG Bitter-type magnet is described. With a given energy dissipation of 12 MW (60 kA, 320 V, 0.4 sec) the solenoid provides at its center a field of 120 kOe with a useful inside diameter of 10 cm and a length of 85 cm. Five windows for diagnostics are distributed along the length of the coil. Their influence on the field distribution should remain within a limit of 3 per cent. The magnet is cooled during the pulse intervals with water or liquid nitrogen. The solenoid consists of a stack of 265 disks made of hard electrolytic copper, thickness 0.4 cm, inside diameter 11 cm, and outside diameter 33 cm. Each disk is fitted around the outer edge with a soldered copper tube (4 × 0.5 mm) through which the cooling medium circulates. (auth)

6452 (UCRL–50586) DEPLOYMENT HANDBOOK FOR THE CLEANSWEEP IIIB ROCKET SAMPLING SYSTEM. Williams, Richard T. (California Univ., Livermore. Lawrence Radiation Lab.). 3 Feb 1969. 141p. Dep. NTIS.

The Cleansweep IIIB rocket system was developed to provide a nuclear cloud debris sampling capability for early sampling of regions of nuclear clouds unattainable by other means. It provides isokinetic collection to about 120,000-ft (MSL) altitude on full weight IPC 1478 filter paper and can reach altitudes in excess of 150,000 ft. Cleansweep IIIB is the only known operational atmospheric sampling rocket system. (auth)

6453 AUTOMATED SYSTEM FOR RAPID DETERMINATION OF HALF-VALUE THICKNESS. King, R. J.; Lott, S. H. Jr. (Vanderbilt Univ., Nashville). Health Phys.; 19: 681-4(Nov 1970).

An accurate measurement of half-value thickness (HVT) is tedious and time consuming if done manually. An automated system has been developed which allows the complete absorption curve to be measured simply and quickly. A remotely operated unit that will position the desired filters in the beam is placed in front of the machine's collimator. Change in beam output with increasing filter is measured with an ionization chamber with remote readout. This allows a complete absorption curve to be measured in

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less than 2 min after setting up the apparatus. The HVT for any number of kVp and added filtration combinations may be quickly determined. (auth) (UK)

6454 DEPTH GAUGE PROBE ASSEMBLY. Creek, Kenneth O.; Leiby, David W. (to United States Atomic Energy Commission). U. S. Patent 3,535,803. 27 Oct 1970. Filed 19 May 1969.

A device for viewing and measuring defects within a tube in which a depth gauge and mirror are interconnected so that when the mirror is in position to reflect a portion of the tube interior along the tube axis to a television camera the depth gauge is out of contact with the tube interior and when the depth gauge is in contact with the tube interior the mirror is moved aside to permit viewing of a depth gauge dial. The mirror and depth gauge move simultaneously about the tube axis and also longitudinally of the tube. (auth)

6455 METHOD FOR EFFECTING UNIFORM RADIATION OF SAMPLES. Bate, Lamont C.; Dyer, Frank F. (to United States Atomic Energy Commission). U. S. Patent 3,535,205. 20 Oct 1970. Filed 21 Mar 1968.

Samples in a holder are given substantially equal dose in a nonuniform irradiating flux by causing the sample holder to rotate about two perpendicular axes one of which is inclined at about 45° with respect to the direction of the irradiating beam. Rotation of the holder about one of its axes is accomplished by direct mechanical means, and rotation about the other axis is accomplished by a vacuum motor. (auth)

6456 VALVES FOR FLUID FLOW. Todd, William Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,211,035. 4 Nov 1970. Filed 24 Jan 1968.

Reference is made to valves for use in a nuclear reactor to close the ends of complexes of vertically extending pressure tubes, arranged in a lattice pitch, for containing nuclear fuel and coolant. Since for nuclear physics requirements, the tubes must be closely aligned, there is normally insufficient space for conventional valves having horizontal spindle extensions carrying gearing for remote operation. The valve described avoids the need for such extensions. It comprises a spherical and apertured closure member rotatable within a housing having two opposed pots on a common axis, and a bevel-geared actuating shaft with its longitudinal axis parallel to the port axis. The closure member has gear teeth formed in its spherical surface for engagement with the bevel-geared actuating shaft, and the combination is arranged so that the closure number can be rotated within the housing between valve open and valve closed positions. (UK)

6457 PNEUMATIC SCRAM ROD DRIVE. Germer, John H. (to United States Atomic Energy Commission). U. S. Patent 3,535,206. 20 Oct 1970. Filed 8 Aug 1968.

A single purpose drive which withdraws an individual control rod from the core of a nuclear reactor and holds it in a cocked position until a scram signal is received is described. The control rod is withdrawn and held in the cocked position by a vacuum pump arrangement and upon a scram signal is driven into the core by a high pressure fluid, such, as argon, acting on a drive piston. Simplicity and reliability as well as inherent fail-safe features are provided with no critical sliding seals or secondary fluids employed. (auth)

6458 CODE FOR STRESS ANALYSIS BY THE THREE DIMENSIONAL FINITE ELEMENT METHOD. Mori, Koichi (Kawasaki Heavy Industries, Ltd., Kobe, Japan). FAPIG (Tokyo); No. 55. 188-92(Dec 1969). (In Japanese).

The ASME Boiler and Pressure Vessel Code, Section III, is occasionally applied as the technological criteria in the design of a reactor pressure vessel. In this, however, the necessity for stress analysis is indicated, but often the method of analysis is not shown. A variety of stress analyses were made in the design of a steam generator for the PNC's 50-MW test loop, by the use of several calculation codes, including that of three-dimensional axis-symmetry structure stress analysis. But at some positions, e.g., nozzle strengthening, tubular plate, etc., the treatment of axis-symmetry was impossible. The codes for three dimensional structure stress analysis, STACE and STEREO, were developed, in view of the need for carrying out the stress analysis at such complex positions as above with accurate physical models. (Japan)

6459 INVESTIGATION OF HEAT AND MASS TRANSFER IN A HEAT PIPE WITH A SODIUM COOLANT. Ivanovskii, M. N.; Sorokin, V. P.; Subbotin, V. I.; Shustov, M. V. High Temp. (USSR) (Engl. Transl.); 8: 299-304(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 319-25(Mar-Apr 1970).

Results are presented of an experimental investigation of heat- and mass-transfer processes in a heat pipe. The experiments were carried out at temperatures of 600 to 800°C on a heat pipe with a wick of serge webbing (the length of the pipe was 500 mm, its inside diameter 25.5 mm). It was observed by measurement of the temperature fields in the vapor space of the pipe that the particular wick used is capable of generating a very high capillary pressure (higher than 0.07 bar). (auth)

6460 SURFACE PROTECTION IN NUCLEAR INSTALLATIONS. Grunert, H. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernenergie; 13: 260-2(Aug 1970). (In German).

Protective coatings used in the nuclear installations of the G. D. R. for making the surfaces easily decontaminable are described. Room covers, joint packings, paints for rooms, equipment, and vessels applied according to the special demands are described in detail. Improvements possible in both concrete technology for obtaining perfect concrete surfaces and elaboration of processing and checking directions are pointed out. (auth)

6461 COUPLED PHOTOMETER AND RESPIROMETER. Jacobson, A. P. (Univ. of Michigan, Ann Arbor). Rev. Sci. Instrum.; 41: 1893-95(Dec 1970).

Some radiobiological effects are transient. They occur during irradiation and recover rapidly thereafter. For example, bacterial luminescence is suppressed within seconds by x rays and recovers immediately. Continuous monitoring is essential since lengthy analytical methods will not detect these transient events. Studies aimed at the molecular mechanisms of these immediate and reversible radiation effects indicate the need to measure oxygen and bioluminescence simultaneously, since luminescence, respiration, and many radiation induced reactions require oxygen. A simple arrangement which allows such continuous measurements is described. (W.H.K.)

Heat Transfer and Fluid Flow

Refer also to abstracts 6456, 6459, 7378, 8064, 8068, and 8083.

6462 (AERE-R-5590) CORRELATION OF CRITICAL HEAT FLUX FOR THE VERTICAL FLOW OF WATER IN UNIFORMLY HEATED CHANNELS. Hewitt, G. F.; Kearsey, H. A.; Collier, J. G. (Atomic Energy Research Establishment, Harwell (England)). Aug 1970. 25p. Dep. NTIS (U. S. Sales Only). UK 4s. 0d.

A new correlation of critical heat flux (or burnout) data for tubes is described. This correlation is developed from the critical quality vs. boiling length concept as suggested by earlier Harwell work. The performance of this correlation was systematically tested against a data bank and was compared with that of other commonly used methods. Significant improvements over these other methods are observed. A correlation of similar form which was developed for annuli is described and the application of this correlation to rod bundle data is reported. Encouraging agreement was obtained with data for a wide range of rod bundles. (auth) (UK)

6463 (CEA-CONF-1592) HYBRID COMPUTATION OF A HEAT EXCHANGER. Chareton, Herve; Corriol, Jean-Louis; Poulard, Pierre (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). 1970. 9p. (In French). (CONF-700826-4). Dep. NTIS (U. S. Sales Only).

From Conference on Hybrid Computation, Munich, Germany.

A sodium-water counterflow heat exchanger was studied. It consisted of three parts: an evaporator, an economizer, a superheater and a resuperheater. In the sodium circulation, there is a joint between the exit of the superheater and the resuperheater, before the economizer, but the water circulation between economizer-evaporator and superheater and resuperheater may be considered independent. In the resuperheater there is only dry vapor, although the three phases of water are possible in the economizer and superheater. Two variables are involved, thus the analysis may be made in space or in time. The spatial analysis using the series method (or the Continuous Space, Discrete Time C.S.D.T) was considered to be the best. At a given instant a single system of equations represents the exchanger. From the point of view of phase and thermodynamic functions the circuits are interchangeable. The exchange coefficients are also studied in this way. This model is considered to be an important step in the development of hybrid programs for vapor generator calculations. In a 0.5 second interval the calculation is made in real time; in this respect it is very useful for control studies. (France)

6464 (CEA-CONF-1648) SIMILARITY BETWEEN TWO PHASE LIQUID-VAPOR FLOWS WITH HEAT EXCHANGE.

Boure, J. A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1970. 10p. (In French). (CONF-700805-3). Dep. NTIS (U. S. Sales Only).
From 4th International Heat Transfer Conference, Versailles, France.

A method of establishing the similarity rules applicable to systems depending upon numerous parameters, such as two-phase flow, is proposed. This method was applied to liquid–vapor flows with heat exchange. For critical heating phenomena (burnout), the rules derived were compared with experimental results. A satisfactory simulation is possible. (auth) (France)

6465 (GEAP-10221) DEFICIENT COOLING. Fourth Quarterly Progress Report, April 1–June 30, 1970. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jun 1970. Contract AT(04-3)-189. 38p. Dep. NTIS.

A simplified analysis of boiling two-phase transients, involving pressure and/or flow decay has been made using the method of characteristics. The results appear encouraging for analysis of transient data and work is presently in progress on evaluation of representative transient depressurization data. Procurement of materials for subchannel sampling of three areas of a nine-rod test section has been completed and installation started. Completion of the installation will be made early in the next quarter (July 1970). One-rod exploratory tests have revealed poor heat transfer conditions around supports of large (1/4 inch) diameter in contact with the heater surface. Flow cycling tests have proved the adequacy of the designed equipment and have also shown that critical heat flux (CHF) is indicated to be sensitive to changes in quality of 0.005 at 1000 psi. The analog-digital conversion routine and programming for calculation of transient data is essentially complete. Some minor de-bugging is still in progress. (auth)

6466 (UCRL-71569) LAMINAR FREE CONVECTION OF HEAT GENERATING FLUIDS IN HORIZONTAL PIPES. Van Sant, J. H. (California Univ., Livermore. Lawrence Radiation Lab.). 24 Jun 1969. 15p. (CONF-700828-2). Dep. NTIS.
From 4th International Heat Transfer Conference, Paris, France.

An analytical study of two-dimensional, laminar, free convection of a constant property, heat-generating fluid in a constant temperature horizontal pipe is reported. Energy, momentum and continuity differential equations in cylindrical coordinates are used to derive dimensionless differential equations describing Grashof number, vorticity function and stream function. These equations were solved numerically using finite differences and an explicit forward time-differencing technique. Steady-state temperature profiles are compared to experimental measurements. Temperature response and local wall heat flux are also reported. (auth)

6467 FLUID VELOCITY AND FLOW MEASUREMENT USING ULTRASONICS. Dory, J. (Societe des Realisations Ultrasoniques, Meaux, France). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 43-9(1969). (In French).
From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

Among all the possible techniques for measurement of fluid velocity or flow, those using ultrasonics are of particular interest due to zero inertia, lack of moving parts, and ease of installation. However the fabrication of apparatus is difficult due to the low actual value of parameters to be measured, so it is necessary to make an exact evaluation of all the spurious phenomenons. The device described was designed to practically cancel all drift, whatever is its origin. Its main characteristic lies in the use of a high speed switching circuit for the probes associated with a synchronous demodulator. These features permitted the quite simple construction of a measuring device having excellent long term stability. (auth)

6468 NEW METHOD FOR THE STUDY OF THE BOUNDARY LAYER IN HIGH-TEMPERATURE GASES. Zysina-Molozhen, L. M.; Petukhov, L. S.; Savel'ev, E. M. Heat Transfer - Sov. Res.; 2: No. 4, 81-8(Jul 1970).

A method is presented for measuring the local variables in the boundary layer of a high-temperature (T = 1500 to 2500°C) gas, including the case of ionized gas flowing in a magnetic field. The method is based on the dependence of absorption of x radiation on the density of the irradiated medium. A description is presented of the experimental equipment, which uses a plasmatron as a high-temperature gas (argon) source. Measured temperature and velocity distributions obtained in the boundary layer of the cooled plate are presented. (auth)

6469 COMBINED CONVECTIVE HEAT TRANSFER IN A VERTICAL CHANNEL OF RECTANGULAR CROSS SECTION. Riley, J. A. (Scottish Research Reactor Centre, East Kilbride, Scotland). J. Brit. Nucl. Energy Soc.; 9: 235-43(Oct 1970).

A description is given of a heat transfer study that was undertaken as part of a programme of work aimed at upgrading the operating power level of the Universities Research Reactor. An electrically driven heat transfer rig was constructed, the test section of which is 26 in. high and of rectangular cross section (3.22 in. × 0.36 in.). The rig generates a constant wall heat flux and the pumped coolant used is demineralized water. It is shown that although Re < 2300, turbulence can occur within the channel, with a consequential gain in the heat transfer coefficient. This turbulence is due to variable fluid property effects (i.e., natural convection) and although its onset position is a function of Reynolds number, the heat transfer immediately before onset and during the turbulent region was found to be relatively insensitive to Reynolds number variations. The criteria that govern the onset of turbulence, the heat transfer immediately before turbulence, and heat transfer in turbulent region were investigated and suitable dimensionless relationships are proposed for each of these situations. It is thus possible (within the range of parameters investigated) to predict the important regions of the channel wall temperature variation from the normally known design parameters. (auth) (UK)

Isotope Technology

Refer also to abstracts 6341, 6382, 6423, 6426, 6455, 6520, 6832, 6857, and 7933.

6470 (BARC-485) TOLL ENRICHMENT OF URANIUM. Balakrishnan, M. R. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 36p. Dep. NTIS (U. S. Sales Only).

The results of an analysis made on the economics of toll enrichment are presented. The theory of isotopes separation in diffusion plants is reviewed, factors which contribute to enriched uranium prices, i.e., feed materials and diffusion process costs, and the optimum of tail enrichment are discussed. Finally, tabulated data are presented on the prices of enriched uranium as UF_6 for assay (wt % ^{235}U) values from 0.71 to 95.0 assuming USAEC costs of \$8.00/lb U_3O_8 for natural U, \$2.70/kg U for U_3O_8 to UF_6 conversion, and \$26/kg unit for separative work, and that the tail enrichment is 0.2 wt % ^{235}U. (L.C.L.)

6471 (NBS-SPEC. PUBL-331) RADIOACTIVITY CALIBRATION STANDARDS. Proceedings of a Special Session of the International Conference of the American Nuclear Society Meeting on the Constructive Uses of Atomic Energy, Washington, D. C., November 10–15, 1968. Mann, W. B.; Garfinkel, S. B. (eds.) (National Bureau of Standards, Washington, D. C.). Aug 1970. 118p. (CONF-681141). GPO \$1.25.

Experimental procedures and methods used in nine international radioactivity standardization laboratories are described. The possibility of attaining accuracies of the order of 0.01% are discussed. The desirability of carrying out consistency checks of gamma-ray standards with time, using a $4\pi\gamma$ ionization chamber is emphasized. The validity of radioactivity standards is examined. International comparisons organized by the International Bureau of Weights and Measures are discussed. An analogue method of liquid-scintillation counting is described. Certain types of radioactivity standards are criticized. The fields of interest of the two Canadian laboratories are discussed. Details of the work in progress at the Boris Kidrič Institute and National Bureau of Standards are presented. (auth)

6472 (NP-18567) MOBILITY OF THE ADSORBATES AND CONDENSATES, EFFECT ON ISOTOPE SEPARATION BY GASEOUS DIFFUSION. Lallemand, Andre (Lyon Univ., France). 1970. 141p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis. Submitted to Lyon Univ. (France). Faculte des Sciences.

Results are given from research on the flow of adsorbable gases in porous bodies and on the isotopic separation of adsorbable gases by gaseous diffusion. In both cases the effects of the adsorbed phase were studied for the entire relative pressure range, i.e., from monolayer adsorption to the capillary condensation zone inclusive. A new method, to determine the pore radius distribution, was developed and enables the flow rate of the gas phase in the flow of an adsorbable gas through a porous body to be obtained. From the study of the mobility of the adsorbed phase it is deduced that the adsorbed molecules move according to the laws of diffusion for a coverage rate <0.7, and that in the multilayer zone the hypothesis of a bidimensional hydrodynamic flow leads to a resistance coefficient definition which varies with the coverage rate. The results of isotopic separation by gaseous diffusion of argon are as follows: for a cover-

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age rate <0.6 the adsorbed phase separation factor is identical with that of the gas phase; in the multilayer zone the adsorbate separation coefficient varies between the value of the gas phase coefficient and zero; in the capillary condensation zone, the separation takes place at the expense of the heaviest element. (France)

6473 ^{252}Cf PROGRESS. Californium-252 Progr.; No. 1, 1-32(Oct 1969).

ACTIVATION ANALYSIS—neutron source for, evaluation of californium-252
ATMOSPHERE—sulfur content of, performance of californium-252 sources for measurement of
CALIFORNIUM-252—evaluation for use as neutron source in well logging
—evaluation of uses of
—production of, technology for
—handling and transport of, licenses for
—shipping of, containers for
MINERAL DEPOSITS—prospecting by in situ neutron activation using californium-252 source
NEUTRON SOURCES—evaluation of californium-252, for use in well logging
—evaluation of californium-252
RADIOGRAPHY, INDUSTRIAL—neutron source for, evaluation of californium-252
RADIOTHERAPY—neutron source for, evaluation of californium-252
REMOTE-HANDLING EQUIPMENT—shielding for californium-252
SHIPPING—containers for californium-252
SOILS—density of, use of californium-252 source for measuring
—water content of, use of californium-252 source for measuring
SULFUR—content in atmosphere, performance of californium-252 sources for measurement of
WELL LOGGING—neutron source for, evaluation of californium-252 (P.C.H.)

6474 ^{252}Cf PROGRESS. Californium-252 Progr.; No. 2, 1-43(Jan 1970).

BERKELIUM-249—production as by-product of californium-252
CALIFORNIUM-249—production by californium-252 decay
CALIFORNIUM-250—production by californium-252 decay
CALIFORNIUM-251—production by californium-252 decay
CALIFORNIUM-252—evaluation of uses of
—information center for
—availability of small sources of
—production in Savannah River Production Reactor, evaluation of
—shielding of, materials for
—fabrication of point sources of Savannah River Laboratories at
—neutron emission anisotropy in spectra measurements
COBALT-60—production of high specific activity, during reactor production of californium-252
CURIUM ISOTOPES—production as intermediate to californium-252
EINSTEINIUM-254—production as by-product of californium-252
FERMIUM-257—production as by-product of californium-252
INFORMATION CENTERS—establishment of californium-252
MINERAL DEPOSITS—prospecting by in situ neutron activation using californium-252 source
NEUTRON SOURCES—evaluation of californium-252
—emission anisotropy in spectra measurement of californium-252
PLUTONIUM-238—production of high specific activity, during reactor production of californium-252
PLUTONIUM-244—production as by-product of californium-252
RADIATION DOSIMETERS, THERMOLUMINESCENT—development of Bonner lithium fluoride, for personnel neutron dosimetry
RADIOGRAPHY, INDUSTRIAL—neutron source for, evaluation of californium-252
RADIOTHERAPY—neutron source for, evaluation of californium-252 (P.C.H.)

6475 ^{252}Cf PROGRESS. Californium-252 Progr.; No. 3, 1-33(Apr 1970).

ATMOSPHERE—sulfur content of, performance of neutron sources for measurement of
CALIFORNIUM-252—evaluation of uses of
—availability of small sources of
—handling of large sources of
—shielding for neutron sources of
MINERAL DEPOSITS—prospecting by in situ neutron activation using californium-252 source
NEUTRON SOURCES—availability of small californium-252
—handling of large californium-252
—evaluation of californium-252
—shielding for californium-252
RADIOGRAPHY, INDUSTRIAL—neutron source for, evaluation of californium-252
RADIOTHERAPY—neutron source for, evaluation of californium-252
SULFUR—content in atmosphere, performance of neutron sources for measurement of (P.C.H.)

6476 INSPECTION OF HAND GRENADE FUSE DELAY ELEMENT BY A RADIOACTIVE TRACER TECHNIQUE. Semel, Stanley; Gilford, Martin; Helf, Samuel (Picatinny Arsenal, Dover, N. J.). Mater. Eval.; 28: 246-50; 256(Nov 1970).

Incorporation of a radioactive tracer within the delay composition provides a highly reliable method for the inspection of the delay column height in the M200 series hand grenade fuses. The resulting gamma-ray signal from each fuse gives a quantitative measure of total delay charge weight. Based on measurements with plant-size batches of delay composition, levels of radioactivity can be such to accommodate an inspection rate of two units per second with a single inspection unit without exceeding permissible external radiation dose levels. The inspection unit itself would consist of a simple, rugged, inexpensive scintillation-counter assembly. The radioactive tracer element need not be common to the delay composition ingredients but can be added to the mixture as a foreign material in ppm concentration. Thus a wide range of radiation half-lives and gamma-ray energies can be used. The radiological safety factors associated with the handling of bulk quantities of radioactive materials in an ammunition loading plant are discussed briefly. (auth)

6477 URANIUM ENRICHMENT IN EUROPE. COMPARISON BETWEEN THE REPORTS OF THE EURATOM AND FORATOM STUDY GROUPS. Scuricini, Giovanni B. Com. Naz. Energ. Nucl., Notiz.; 16: No. 3, 33-7(Mar 1970). (In Italian).

The EURATOM and FORATOM reports on the economic future of uranium enrichment in Europe are in essential accord; the basic disagreements occur because of the different times at which the two reports were made. The FORATOM report was begun in January 1967 and the EURATOM report in March 1968. The cost evaluations for the design and construction of enrichment installations are compared. The economic aspects of the gaseous diffusion process, the ultracentrifuge, and the separation nozzle method are considered. It is concluded that the work of the FORATOM group be continued in order to prepare work schedules for continuously evaluating the evolution of the cost and market situation. (J.S.R.)

6478 GAS CENTRIFUGE AND A PROCESS FOR ENRICHING ^{235}U. (to Doryokuro Kakunenryo Kaihatsu Jigyodan). British Patent 1,212,449. 18 Nov 1970. Priority date 26 Oct 1967,Japan.

A method of enriching and separating ^{235}U without gas condensation is described. The centrifuge used consists of an outer chamber and an inner chamber which rotates relative to the outer chamber. The chambers are arranged in cascades incorporating a supply step, a plurality of enrichment steps and a plurality of recovery steps for separating UF_6 depleted in ^{235}U from UF_6 enriched in ^{235}U. (J.R.D.)

6479 SEPARATION OF LIGHT ISOTOPIC GAS MIXTURES IN THE THERMAL DIFFUSION COLUMN. Rutherford, W. M. (Monsanto Research Corp., Miamisburg, Ohio). J. Chem. Phys.; 53: 4319-24(1 Dec 1970).

The theory of the thermal diffusion column, originally developed by Jones and Furry for mixtures of heavy isotopes, is extended to include mixtures of light isotopes, the properties of which depend on composition. The transport equation which results is similar to previous equations for mixtures of heavy isotopes, but atom fractions are replaced by mass fractions. Experimental separation measurements of the ^{3}He–^{4}He system were used to test the theory. The predicted effect of ^{3}He concentration on the reduced initial transport coefficient is closely followed experimentally. The general agreement between theory and experiment is within the mutual uncertainties of the experiments and of the calculations. The uncertainty in the experimental column transport coefficients is estimated to be ±9%, and the uncertainty in the coefficients calculated from theory is estimated to be ±5%. The theory is also expected to

apply to the separation of mixtures of unlike gases, although this aspect was not tested experimentally. (auth)

Materials Testing

Refer also to abstracts 6454 and 6467.

6480 NONDESTRUCTIVE TESTING AND CONTROL IN THE FIELD OF NUCLEAR METALLURGY AND TECHNOLOGY. 12th Conference on Metallurgy, Saclay, 24, 25, and 26 June 1968. Colloques de Metallurgie Speciale Precedemment Publies. Paris; Presses Universitaires de France (1969). 397p. (In French and English). (CONF-680606).

Forty-three papers were presented at the conference. A separate abstract was prepared for each of 32. Ten were previously abstracted in NSA. For abstracts of these, see CONF-680606 in the Report Number Index. One paper was not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 6467 and 6481–6511.

6481 ULTRASONIC TESTING OF CERTAIN PROPERTIES OF STEEL. Pawlowski, Zdzislaw (Institut Podstawowych Problemow Techniki, Warsaw). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 9-13(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

The ultrasonic wave technique is a very powerful tool in testing the macrostructure and microstructure of materials. Some new possibilities of ultrasonic testing in phenomena-oriented research, when use is made of different parameters characterizing the propagation of ultrasonic waves in a solid body are described. The properties of solid materials of most pertinent interest are the microstructure, the ability of a material to behave in a brittle or in a ductile manner, its elastic and anelastic behavior. It is also of great interest to explore the internal stresses in materials subjected to heat treatment. Some of these aspects are presented, and are based on the results obtained in the Laboratory for Nondestructive Testing in the Institute for Basic Technical Problems of the Polish Academy of Sciences IPPT-PAN. (auth)

6482 USE OF ULTRASONICS FOR TESTING FOUNDRY BILLETS AND WROUGHT EXTRUSION PRODUCTS IN ALLOYS OF THE Mg–Zr TYPE FOR CANNING. Bitran, M. (Trefimetaux GP, Argenteuil, France); Destribats, M.-T.; Lestiboudois, G.; (and others). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 15-24(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

Ultrasonic frequencies are particularly suitable for examining the quality of parts with a magnesium base, and it was therefore quite logical to try and adapt a method based on their use for testing the quality of cans for fuel elements of the natural uranium/graphite/CO_2 system. Inspection at the factory was carried out in two stages, first in the foundry (on billets) and then after extrusion (on semi-finished products). It was important to establish whether there was a relationship between the quality classifications at the two stages of inspection. For this purpose an experiment was carried out on 24 billets of different quality and 260 extrusions produced from them. The influence of superficial defects on the quality classification of the extrusions was studied. Conclusions were obtained on the practical value of the two types of inspection. (auth)

6483 THEORETICAL AND EXPERIMENTAL STUDY OF SOME ULTRASONIC EMITTERS. Broudin, Y.; Ferenczy, G.; Marini, J. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 31-41(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

In certain problems related to nondestructive testing, the detection of small defects requires a knowledge of the energy distribution inside the scanning beam. If, in fact, the beam used for probing has a much larger width than the size of the reflecting surface of the defect, this defect could produce different signals depending on whether it is in a zone of low acoustic energy or in one of higher acoustic energy. An emitter of circular shape is cited very often in the literature but no detailed results are given concerning transducers of different shape. In fact many emitters used industrially have piezo-electric discs of rectangular shape, for example. After a theoretical study of the acoustic field of some circular, rectangular and line focussed emitters, some experimental results obtained are presented. The theoretical study yields some formulas and also gives a good idea of the difficulty of the problem. The experimental work verifying fairly well the theory, has shown that diffraction effects are very important, even when the transducer is excited by pulses, and that the energy distribution inside the ultrasonic beam is extremely complex and can vary considerably from one point to another. It would therefore be wise, in considering the propagation of ultrasonics, to take these factors into account. (auth)

6484 MEASUREMENT OF GRAIN SIZE USING ULTRASONICS. Aldridge, E. E. (Atomic Energy Research Establishment, Harwell, Eng.). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 53-7(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

When ultrasonic waves are radiated from a transducer into a homogeneous specimen of metal, which is free from major defects, the sound scattered back to the transducer has characteristics which depend upon the macrostructure of the metal. For specimens which have a similar composition but differ in grain size, this ultrasonic scatter can be used to rank the specimens in order of grain size. In the Rayleigh region, where the ultrasonic wavelength is much larger than the grain size and the scattered sound is proportional to grain volume, the transducer will isonify a large number of grains and moving it will cause its output, due to scatter reception, to change owing to the changing relative phases of the scatter of individual grains. This is analogous to radar clutter, and it will have a probability distribution of amplitude which is dependent on grain size. Experimental work is being carried out to test the usefulness of this idea using smooth stainless steel tubes of 14.5 mm diameter, 0.76 mm wall thickness, about 20 cm long and of known mean grain size. The ultrasonic frequency is 10 MHz and the range of grain size is up to 100 microns. The probability distribution and mean level of the scatter amplitudes is obtained using standard nucleonic instrumentation. Although the probability distribution is dependent on grain size, it is not an absolute measure owing to the many acoustic variables involved. It is necessary, therefore, to estimate the unknown grain size of a specimen by comparing its probability distribution or mean scatter with those taken previously on specimens of known grain size. The attractiveness of the method is that it has the possibility to sort a very large number of similar specimens according to macrostructure and so give direction to any destructive metallurgical quality control. (auth)

6485 PROPERTIES OF ULTRASONIC CONTROL SYSTEMS, THEIR DEFINITION AND MEASUREMENT. Krautkraemer, J. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 59-64(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

In nondestructive testing of nuclear reactor construction components the reliability of the ultrasonic equipment is of great importance. Unfortunately up till now there exists no compulsory definition of the characteristics, nor of the way to measure them. As far as the first attempts are concerned, it can be objected that they do not take sufficiently into account the characteristics of the electronic apparatus, nor the properties of the ultrasonic field of the probes. Therefore some of the most important characteristics, are defined, the measurement methods are explained and compared with tests already carried out. For the impulse-echo apparatus, the following are defined: sensitivity; resolving power; working frequency; and amplification curve with the value of the threshold and the saturation. For the probe, the following are defined: loss-coefficient of the probe; length of the near field; and working diameter of the vibrating disc. The sensitivity of the apparatus as well as the loss coefficient of the probe which together give the available sensitivity, depend on the physical limit of the amplifier background noise. The input and output impedances of the probe and of the amplifier are important for the definitions and the measurements. As far as the other characteristics of the set-ups are concerned, electronic measurement methods which replace normal methods using standards are discussed. (auth)

6486 PROGRESS WITH THE ULTRASONIC TESTING OF SMALL TUBES FOR THE NUCLEAR INDUSTRY. Malrin, J. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 65-72(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

An improved ultrasonic testing method is described which is more efficient than presently used ultrasonic methods for detect-

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ing flat internal defects in small seamless steel tubes for nuclear applications. This improvement was achieved in two successive stages: adoption of conventional testing by transverse scanning with a more severe threshold 0.2 mm instead of 0.3 mm; and development of an additional testing process with greater efficiency with respect to flat internal defects than the conventional test with a threshold of 0.2 mm. The process uses two pairs of transmitter-receiver probes mounted head to tail, each pair being situated in the same cross-section, as in the conventional US test, but arranged differently. The transmitter probe is set at a slight angle (a few degrees with respect to the tube), so that the beam emitted undergoes successive reflections with a very close pitch on the external and internal walls of the tube under test; when the ultrasound meets an interface with a trace which is not very oblique with respect to the tangent of a circle centered on the axis of the tube, the beam is deflected at each rebound to the natural defect and then collected by the receiver-probe set at a certain distance from the transmitter-probe at a greater angle. The optimum orientation of the receiver-probe was established experimentally so as to obtain a maximum response on a natural defect occurring in the form of a line inclined at 10° with respect to the internal wall of the tube, which had escaped the conventional U.S. test; it was confirmed at the same time that a radial U notch, used at present for calibrating the conventional installations, did not give a return echo with this new process which is thus complementary to the conventional test. Tests at the industrial stage showed that the device was capable of detecting flat internal defects not found by the conventional test. Apart from these anomalies, the apparatus is sensitive to internal splits, the trace of which is roughly parallel to the surface of the tube; to internal hollows; to external grinding; to eccentricity in the walls; and to shock deformations. For certain flat defects the test margin left by the process and the increased sensitivity which would have been required by the traditional test were noted. The industrial test, carried out on several thousand tubes, which had previously undergone the conventional U.S. pass with a threshold of 0.2 mm, showed that the process could be used to eliminate harmful internal defects; on the other hand, because of the sensitivity, which was deliberately set high to ensure efficiency with respect to harmful internal defects, this test led to the rejection of a certain number of tubes either for slight admissible internal defects, or for admissible defects of shape; from the position of the harmful defects to be rejected, visual inspection and visual inspection aids do not permit reliable sorting of suspect tubes in great lengths. (auth)

6487 ABOUT ELECTRONIC POSSIBILITIES TO CORRECT SCREEN INDICATIONS OF AN ULTRASONIC TESTING EQUIPMENT: ADVANTAGES AND DISADVANTAGES. Lehfeldt, W.; Baumbauer, W. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 73-8(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

The problems of obtaining meaningful screen indications of material defects detected by ultrasonic methods and electronic methods for solving these problems are discussed. These electronic solutions include: rectifying and filtering pulses; suppression of the zero point; logarithmic amplification to increase echoes of small defects, and sweep controlled gain to allow indications of echoes of small defects at longer distance as high as those of the narrow field. New testing equipment developed as a precise measuring instrument that permits all corrections of screen indications and that is suitable for all testing problems, is described. (L.C.L.)

6488 VISUAL DISPLAY OF ULTRASONIC IMAGES USING AN ULTRASONIC CAMERA. Marini, J.; Roule, M. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 79-84(1969). (In French).

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The analysis of results and the observation and interpretation of signals in the field of ultrasonic nondestructive testing, is often done by specialists whose diagnosis may not always be entirely objective. Ultrasonic nondestructive test processes giving results accessible to the non-initiated are not at present in very common use, whereas a radiograph, for example, can generally be interpreted without difficulty. The aim of ultrasonic visual display using an ultrasonic camera is to represent acoustic images on a television screen. After describing the working principle of the system the results obtained to date are presented, and the immediate applications and future lines of research in the field, are indicated. This research covers on the one hand the improvements still to be made to the apparatus, and on the other hand the possible applications of an improved version, extending beyond the field of conventional nondestructive testing. (auth)

6489 HIGH-SPEED FACSIMILE DISPLAY OF FLAW SIGNALS OR METROLOGICAL READINGS FROM TUBES. Goobermann, G.; Mann, C. A. (Univ. of Salford, Eng.). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 85-91(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

When a component such as a tube is inspected for flaws, or to check its dimensions, it is often convenient to display the results in plan form. A rectangular format represents a developed plan of the tube, one side of the rectangle representing the length of the tube and the other side its circumference. The use of facsimile recorders such as the Muirhead Mufax for producing displays of this sort, was demonstrated. The equipment described uses a system of cathode-ray storage tubes to produce a continuous television-type raster display. Information derived during successive revolutions of the tube i.e., successive lines of the display, is written alternately on two storage tubes. During the period when each tube is not receiving information, it is read and the line is written on the third tube. All previous lines except the earliest one are transferred from the fourth to the third, below the new line. The fourth tube then receives the new picture from the third tube. A display is continuously scanned from the fourth tube. The continuous addition of new lines produces a moving picture in which any feature remains in view for a time depending on the number of lines on the raster and the rate of scanning of the test rig. (auth)

6490 PENETRATION OF CONCENTRATED PULSED ELECTROMAGNETIC FIELDS INTO A CONDUCTOR. Chan, S. B.; Waidelich, D. L. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 111-17(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

In the nondestructive testing of metals using pulsed eddy currents much higher resolution is achieved by the use of masked probes. It is necessary to have more knowledge about the electromagnetic fields and current densities in the metal under such probes so that, for example, the depth of penetration in the metal may be determined. Also in observing the output waveforms of the pulsed eddy current system, it is desirable to know the positions in time at which the various items of information about the metal specimen occur. An experiment showed that the field immediately under the aperture of the masked probe could be either symmetrical or not symmetrical in form. It was found, however, that much stronger fields were obtained when the field was not symmetrical, so the analysis presented here is the more practical case of the field that is not symmetrical. A unit time impulse of field distributed exponentially along the surface of the metal is assumed. The wave equation for the conductor is solved using Laplace transforms for the time variable and Fourier–Bessel transforms for the space variables. The boundary conditions are fitted and the solution for the fields and current densities in the metal may be expressed in the form of an infinite integral which does not appear to be of a form that may be evaluated in a closed expression. An asymptotic series representation was found that allowed numerical solutions to be made readily with the aid of a computer. The numerical results have been plotted as a series of curves showing the variation of the current density in the metal as a function of time and of depth into the metal for various electrical conductivities of the metal. The current density is also shown as a function of the radial distance measured parallel to the surface of the metal from the point at which the maximum value of the field is applied. Some curves in terms of generalized parameters are also shown. (auth)

6491 APPLICATION OF PULSED-ELECTROMAGNETIC FIELD METHODS TO LIQUID-METAL FAST REACTOR NONDESTRUCTIVE TEST PROBLEMS. Renken, C. J. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 119-26(1969).

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Pulsed-electromagnetic methods possess advantages that make them attractive methods for application to certain problems that arise in the construction and operation of liquid metal-cooled fast reactors. These problems include the testing of fuel element jacket tubing and the detection of bond defects in liquid metal-bonded fuel elements and capsules. The pulsed-electromagnetic method offers a compromise between high speed sinusoidal electromagnetic methods and high resolution ultrasonic methods that is especially useful on jacket tubing of under 0.5 mm wall thickness. Equipment is described that uses high resolution transducers to produce a relatively wide-band transducer spectral response for defect sensitivity, and uses sampling to provide equal sensitivity to inner surface and outer surface tubing defects. The standards commonly

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used for jacket tubing inspection applications are discussed, and a selection of typical defects discovered in thin-walled stainless steel are illustrated by microphotographs. Pulsed-electromagnetic methods are ideally suited for the detection of bubbles and voids in liquid metal-bonded fuel elements and test capsules. By means of pulse sampling, the depth of the defect in the sodium can be accurately estimated. When long duration current pulses (20 μsec or greater) are used, defects covered by 2 mm of sodium are easily detectable. Shorter pulses and high resolution transducers are well suited to very accurate measurements of sodium levels. The transducers are insensitive to ambient temperature, so that sodium measurements are customarily made with the sodium molten. These pulsed electromagnetic test systems operate with lead lengths between transducer and electronic equipment of 30 meters or more. This fact, as well as the simplicity and ruggedness of the transducer make them well suited for hot cell or in-reactor applications. (auth)

6492 DESCRIPTION OF A TESTING APPARATUS MAKING USE OF EDDY CURRENTS, CFS 67. FIRST RESULTS. Pigeon, M.; Destribats, M.-T.; Desclee, B. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 127-35(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

In an effort to improve reliability, increasingly necessary in the nuclear field, a test method making use of eddy currents has been developed at the same time as the ultrasonic method, which requires a coupling liquid. Research is also being devoted to automation and the visual display of defects. An original apparatus with which cladding can be analyzed by means of sinusoidal signals was developed. Its frequency can be varied continuously from 300 Hz to 300 kHz. The results obtained on several types of stainless steel, magnesium and beryllium cladding are described also. (auth)

6493 LONG DURATION CONTACT-LESS MEASUREMENT OF THICKNESS VARIATIONS IN THE AUSTENITIC STEEL TUBING OF THE PRIMARY CIRCUITS IN THE CZECHOSLOVAK REACTOR VVR-S. Vozenilek, Frantisek (Inst. of Nuclear Research, Rez, Czech.). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 137-9(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

The measurements carried out over a period of 4 years of variations in the thickness of austenitic steel tubing from the cooling circuit in the reactor VVR-S are described. The starting point for these measurements was the laboratory determination of the artificial corrosion attack of stainless steel samples. For real measurements, the bends in the pumping circuit were used; it was assumed that it was here that the distilled water flowing in the primary reactor circuit has the maximum effect. The decreases in the wall thickness measured without contact are tabulated. It was observed that the length of operation of the pumps for the distilled water depends on this thickness. The method is based on the excitation of eddy currents in the object, and on the measurement of its electric conductivity. (auth)

6494 ELECTROMAGNETIC METHODS WITH EXTREME DEFECT RESOLUTION FOR NONDESTRUCTIVE TESTING OF REACTOR TUBES. Foerster, Friedrich (Institut Foerster, Grathwohlstr, Ger.). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 141-53(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

A very important problem in the case of cans is the detection of defects e.g., very small holes, pores, and surface defects. Both internal and external defects should be detected with the same sensitivity as far as possible. Generally speaking the resolution, i.e., the limit at which defects of very small depth and width can still be detected, depends on the size of the volume of the tube which can be controlled at any one time by the probe. For defect control by the eddy current method either feed-through coils or pick-up coils are used. In the case of feed-through coils which form a ring surrounding the sample, all the circumference of the tube along a certain length of tube is controlled at the same time. Because of this, the resolution of defects, pores, holes, and slight surface defects by the signal when the eddy-current method is used with a feed-through coil is insufficient for defects of very small length and width, in the 50 μm zone. With the ultrasonics method it is not possible to focus the sound beam sufficiently for a defect of the above dimensions to be detected in the background noise without ambiguity. This is true for defects both of the crack type and of the hole type, as can be formed by the action of dust particles during the drawing process. For the detection of can defects, very high resolution coils were developed which examine the sample by means of eddy currents and which have a very sharply focussed field; they are thus able to control a very small volume of tube at any one time. (auth)

6495 USING NUCLEAR EXPERIENCE TO SET UP A NATIONAL CENTRE FOR NONDESTRUCTIVE TESTING RESEARCH. Sharpe, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 155-60(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

With the successful realization of economic nuclear power production in Great Britain, the reduced demand on the continuing program of research and development has allowed effort at A.E.R.E., Harwell to be diversified into non-nuclear activities. Nondestructive testing is one of the areas identified in this way and the Nondestructive Testing Center established within Harwell has now been operating for over a year. It has the dual responsibility of continuing to provide research and development in aid of the national reactor program and also meeting the demands of any other industry whose specific inspection problems cannot be met by existing NDT instruments or services. The setting up and operating experience of the Center is explained and in particular how a background of experience in nuclear requirements has served as an advantage in developing an activity of this kind is discussed. The various interests and objectives of the Center are described and details are given of some of the research and development activities currently in hand and, what is important in a commercially orientated venture of this kind, the justification for their inclusion in the Center's program. (auth)

6496 PROFILE MEASUREMENT TECHNIQUE FOR THE AUTOMATED INSPECTION OF FINNED TUBING. Wells, F. H. (Atomic Energy Research Establishment, Harwell, Eng.). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 163-8(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

A flying spot cathode ray tube scanning system was developed (instead of the conventional shadowgraph) to derive as an electrical waveform the profile shape of small annular cooling fins on long tubing. This electrical waveform is then measured to give information as to whether the fin height and width are within the required mechanical tolerances. These electrical measurements may use either a simple form of display for use during manufacture or an on-line small computer for more comprehensive quality analysis. (auth)

6497 CLASSIFICATION OF DEFECTS DETECTED BY EDDY-CURRENTS IN CANNING TUBES IN FAST REACTORS. Dufayet, J.-P.; Samoel, A. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 169-79(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

The test was performed on several hundred stainless steel small diameter, thin walled tubes. Various methods of nondestructive testing were used successively. In particular, the tubes were eddy-current tested using various frequencies. The instrumentation consists of low-frequency equipment with phase analysis, and of a laboratory device working at higher frequency with better resolution. The interpretation of the observed signals can be made by comparison of the various records. In all the micrographic cross sections observed, evidence of manufacturing defects was found. (auth)

6498 NONDESTRUCTIVE TESTING OF WELDS BY MEASUREMENT OF ELECTRICAL CONDUCTIVITY. Andreescu, N. (Inst. of Atomic Physics, Bucharest); Pascu, A. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 189-97(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

Measurement of local electric conductivity is an operation which provides information on the homogeneity of a substance and on the variation of its internal structure. As large changes in structure sometimes produce only small variations in local conductivity, these small variations must be detected with great accuracy. The method was used with welds on steel tubes (similar in size to those used for nuclear fuel cans) and can be used for testing can-end cap welds on types of fuel in current use. With the aid of two suitable electrodes, an intense electric current (up to 50 A) is passed through the two welded tubes, previously machined on the outside, to give a uniform current density, reach-

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ing as much as 200 A/cm². A device with two fine contacts set close to each other slides along a generatrix of the tube, permitting the detection of a voltage which remains constant if the material is homogeneous and the cross section does not change. Near the weld this voltage varies in accordance with a characteristic curve depending on the quality of the weld. The sensitivity of measurement of the variations in voltage can be considerably increased by using an opposition method, in which the reference quantity used is a voltage proportional to the current passing through the specimen. An ac potentiometer fitted with a galvanometer having a sensitivity of 8 μV/mm at 50 cps enables any voltage variation exceeding 10 μV to be measured. The voltage variation-distance curves recorded for different specimens are linked with the internal structures observed by metallography on cross sections of the same specimens. In this way the slope of the curves corresponding to well-produced welds is established. Calculations for determining the voltage variations produced by certain simple defects (plane circular crack, spherical cavity) and the resultant equations for finding the minimum detectable dimensions of these defects are described. The method described is better than radiography and ultrasonic methods for the testing of thin tubes and, in addition, it can be carried out with simpler apparatus. (auth)

6499 CONTRIBUTION TO THE STUDY OF THE HARMFULNESS OF DEFECTS IN FINNED TUBES. Bonnet, P.; Jansen, J.; Veaux, M. (EURATOM–CCR, Ispra, Italy). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 199-208(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

The problem of the behavior of finned tubes subjected to internal hydrostatic pressure has already attracted the attention of scientists. In their use as fuel element cans, the release of fission product gases or the swelling of the fuel causes stresses and strains of this type. In order to assess the value of our rejection criteria, which are intentionally severe, the complex problem of the harmfulness of defects in canning tubes made of SAP for the Orgel project was investigated. The theoretical study of the influence of the fins on the stress distribution in a tube, with or without eccentricity and subjected to internal pressure, was carried out with the aid of photo-elasticimetry and brittle models. The influence of fins, eccentricity and various other metallurgical parameters was studied in parallel under fatigue conditions (pressure cycling). A comparison between the experimental results and theory demonstrated the influence of the geometrical parameters on working life at a given stress. Following a rapid study which showed the great importance of longitudinal as compared with transverse defects, it was decided to investigate the theoretical and practical influence of longitudinal defects on resistance to internal pressure. The following working programs were initiated: theoretical study by photo-elasticimetry; creation of longitudinal internal defects (For this purpose an original fabricating process was developed and its possibilities and limits of its use are described); detection and inspection of artificial defects; and influence of defects of a given shape on fatigue data under internal pressure. It was concluded that the complete study should also cover the detection and influence of natural defects. However, the conclusions drawn from the previous findings revealed certain essential points about the harmfulness of geometrical defects and artificial longitudinal defects. These conclusions should help to guide users in establishing a reasonable rejection standard. (auth)

6500 USE OF THE SPECIFIC PROPERTIES OF LIQUID CRYSTALS IN NONDESTRUCTIVE TESTING. VARIOUS APPLICATIONS. Magne, M.; Pinard, P.; Thome, P.; Chretien, N. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 241-50(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

Substances referred to as liquid crystals have the special property of possessing, in a state intermediate between the true solid state and the true liquid state, characteristics belonging to the crystalline state. These properties are discussed, and tests carried out on different products, either pure or mixed, are described. The change in color over a narrow temperature range was studied in detail. The various possible applications of these products for nondestructive testing, mainly by thermal methods, are presented. (auth)

6501 NONDESTRUCTIVE TEST APPLICATIONS IN THE COMMERCIAL NUCLEAR POWER FIELD. Bailey, T. L. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 265-9(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

Large reactors are built to very close tolerances (when considered as a percentage of their size). Not only is dimensional quality demanded, but materials and welding must also meet very rigid requirements. In order to assure compliance to these exacting requirements, a sophisticated system of inspection and nondestructive testing must be utilized. Planning must begin even prior to the purchase of materials and must include all inspections and tests that the materials, welds, and components will be subjected to from the time of fabrication at the mill until the completed vessel is shipped. Nondestructive tests may range from a simple visual inspection to an elaborate ultrasonic or radiographic inspection. In order to assure that these tests are performed at the proper time and in accordance with the required procedure, Integrated Manufacturing Quality System (IMQ) was developed which lists the nondestructive test points and procedures on shop work sheets (travelers) in the exact sequence in which they must be performed. The subsequent manufacturing operation cannot be performed until the nondestructive test has been completed and so noted on the traveler. (auth)

6502 NONDESTRUCTIVE TESTING IN NUCLEAR STEAM GENERATOR AND HEAT EXCHANGER TECHNOLOGY. Riegel, L.; Sargentini, A.; Sauvagnac, B. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 271-8(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

Work on nuclear equipment and particularly on the design and manufacture of heat exchangers is described. Through numerous projects, decisive industrial experience in design, choice of materials, methods of manufacture and inspection have been acquired. In the field of nondestructive testing, this experience has led to the development of ammonia or helium leak testing, both in the workshop and on the site. In the workshop the ammonia test was used mainly for flash butt-welded headers and tubular heat exchangers and on various exchangers for the more precise location of leaks previously detected with helium. The helium test was applied by using the overall method on the exchangers and vessels. The sniffing method on the helium gas holders, and the helium jet method in particular, were used for locating leaks. The results showed: for Saint Laurent I, 25 out of 60,000 welds ammonia-tested in the workshop, proved to have leaks. Subsequently, 17,000 of them made up into panels and confirmed as being leak-tight to ammonia, underwent an additional overall helium test which verified these results; and of the vessels and exchangers for EL_4 and Rapsodie, only the tube bundles of the intermediate exchangers of Rapsodie revealed helium leaks on some tube plate welds; as it was not possible to locate these leaks precisely with the helium jet, this was done with ammonia. In no case did the overall helium leak tests reveal leaks in areas found to be leak-tight in a previous ammonia test. The ammonia test proved to be more convenient for workshop use than the helium test, especially for the precise location of leaks. The two techniques are in any case complementary. The helium test, which is more delicate, requires greater surface cleanliness than the ammonia test. Finally, the sniffer method or even the helium jet method is difficult to use on large vessels. (auth)

6503 SOME APPLICATIONS OF THE GAMMA SCANNING TECHNIQUE. Pugnetti, G.; Cochi, C. (CNEN, Rome). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 281-8(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

The gamma scanning technique has been especially used at the Casaccia Hot Laboratory as a nondestructive method to evaluate the burnup distribution in irradiated fuel samples. Besides this typical application, the gamma scanning technique has been found helpful in a number of particular applications. Some of these include obtaining fast information on the behavior of the impurities and the stability of the thermocouple sheeting by scanning the fuel samples for detecting individual gamma emitters; determining the diffusion rates of solid fission products at the end of UO_2 pellet stacks; and determining the radial power distribution in cylindrical fuel rods by a radial scanning technique applied on fuel samples irradiated at low reactor power. The results are compared with those obtained by the destructive method of microdrilling. (auth)

6504 DEVELOPMENT OF A DEVICE FOR A METHOD OF AUTORADIOGRAPHY IN α, β, AND γ HOT CELLS UNDER α SHIELDING. Nauche, R. (EURATOM-CCR, Brussels); Planchon, J.; Van Loon, C. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 289-302(1969). (In French).

From Symposium on Nondestructive Testing and Control in

the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

In the hot laboratories of the GEX (group for operation of the BR.2 Reactor and its associated installations) the equipping of the metallography chain has necessitated the development of new techniques for the metallographic examination of irradiated elements. The autoradiography of radioactive samples in α, β, and γ hot cells under α shielding was at first conducted empirically. The equipment and the method of work, together with the procedure for handling emulsions under α shielding, are described. The first development experiments also afforded an opportunity for testing certain standard emulsions. The experience gained subsequently guided the choice of suitable films for this type of examination. The results obtained compare the qualities of the emulsions and show the efficiency of the equipment and also of the method of autoradiography used. (auth)

6505 IMPORTANCE OF THE DEVELOPMENT OF RULES FOR DETERMINING THE CHARACTERISTICS OF THE APPARATUS USED IN ULTRASONIC INSPECTION. Evrard, M. (Institut de Soudure, Paris). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 305-9(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

In ultrasonic inspection, the identification and location of defects constitute two essential operations which require exact knowledge of the characteristics of the apparatus used. Although these characteristics can be determined afterwards by means of a known calibration block, such as that recommended by the International Institute of Welding (IIW), it may also be wise to specify what is required of an apparatus before it is bought. Similarly, it may be useful to compare two pieces of working apparatus in order to be able to choose the right equipment for particular examinations. This is why the IIW has produced a general method for checking characteristics of apparatus by means of the recommended calibration block. It is considered that the following characteristics can be evaluated with sufficient accuracy to satisfy most of the requirements met with in practice: linearity of the time base; linearity of amplification; resolution; and penetration power. The proposed method and examples of results obtained with different types of equipment are described. Each point is thus discussed on the basis of actual measurements and the problem of constancy of characteristics between probes of the same type is examined. The possibility of working out a draft standard will also be mentioned. (auth)

6506 SETTING OF TRANSDUCERS IN ULTRASONIC INSPECTION TANKS FOR CANNING TUBES. Gerard, J.; Mantelle, J. (Societe Vallourec, Montbard, France). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 311-16(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

A description is given of the progress and successful completion of work carried out with the initial objective of reducing the time taken in setting transducers because settings are made by untrained personnel who perform rough and illogical operations blindly and at random. The sequence was as follows: fine and logical maneuvering; and logical position finding. At this stage it was already possible to rationalize the position finding: the operator notes the results obtained according to the positions tested. It also became possible to repeat a known test quickly, several times, and to accumulate information assigned to precise states. These logical reference marks, in this case geometric, gave the angle of incidence which determines the test. The problems of finding this angle, caused by the geometry and mechanics of the test tank, by the imperfections of the tube (bowing, ovalization, mean radius) and by the acoustic eccentricity of the transducers, were analyzed. Variations of this angle were estimated during the test. We are now seeking, by empirical but graded information, or by physical calculation, to provide the operator with the co-ordinates which he must set up on the test tank within strict tolerances. (auth)

6507 ULTRASONIC TESTING OF CANNING TUBES FOR THE MARVIKEN REACTOR BOILER FUEL ELEMENTS. Soederstroem, Gunnar; Thoernqvist, Roland (Aktiebolaget Atomenergi, Stockholm). Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 321-8(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

A description of the production ultrasonic testing of the canning tubes is presented. A pulse echo immersion testing technique is applied using commercially available instruments with 4 MHz line focused transducers. Specially designed transducer blocks and tube feeding equipment have been developed. The present technique for the testing of transducers and for fabrication of standard notches used for defect size calibration is reviewed. Some of the test results obtained are discussed. (auth)

6508 ULTRASONIC BOND TESTING BETWEEN TUBES AND METALLIC URANIUM CORE IN NUCLEAR FUEL ELEMENTS. Pawlowski, Zdzislaw (Institut Podstawowych Problemow Techniki, Warsaw); Wiaderny, Mieczyslaw. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 343-6(1969).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

Incorrect bonding between tube and metallic uranium core in nuclear fuel elements is the reason of insufficient heat transport. This may lead to leakage in fuel elements and as a further consequence breakdown may occur. An effective ultrasonic method of testing the bond quality between tube and metallic uranium core is described. (auth)

6509 RADIOGRAPHIC INSPECTION OF WELDS ON ELEMENTS FOR GRAPHITE-GAS REACTORS. Guittet, J.-C. (SICN, Veurey-Voroise, France); Artru, C. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 353-7(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

Industrial inspection of the internal quality of the end welds of fuel elements has led to the development of several methods suited to elements of either the Chinon or the Bugey type. These various methods are characterized by a developed record of the weld (individual film associated with the element, or film in a continuous strip independent of the element). The sources used, according to the circumstances, are crystallography tubes, highly collimated industrial radiography tubes or the actual enclosure of the electron bombardment welding machine using the x-rays generated in situ. The resolution achieved in these tests is satisfactory. Industrial application is envisaged. The results of the different methods will be given. (auth)

6510 EXAMINATION OF FUEL ELEMENT CAN CLOSURES BY THE MULTIPLE-EXPOSURE AUTOMATIC RADIOGRAPHIC METHOD. Jansen, J.-C. (EURATOM-CCR, Ispra, Italy); Jehenson, P.; Luchtmans, F. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 359-73(1969). (In French).

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

The radiographic examination of welds is in itself well known. This method has been used successfully to examine the can closures of Orgel fuel elements (fuel: UC, finned cans of SAP) including examination of the weld and can at the end cap; and checking that the fuel pellets are correctly stacked and the gas space. The process developed is described in detail as well as the means used to increase the number of radiographic exposures made at the same time; a special bench was constructed for this purpose. The results obtained are discussed, in relation to those of other destructive and nondestructive tests. The limits of validity of this particular inspection are outlined. The inspection procedure for fuel elements during and after fabrication involves a number of conventional techniques. Of these, one inspection stage is considered in more detail; certain dimensional tests and their graphic or digital recording. For example, the measurement of internal diameters by multi-jet pneumatic plugs and the digital display process are analyzed. Equipment was developed that inspects the can tubes automatically and gives simultaneously, visual indications, a graphical record, a column of figures, and a punched tape. This very flexible apparatus permits direct reading of data. In addition, computer processing can facilitate its use by calculating certain parameters and displaying the results in the form of very legible tables. The digital system can also be adapted to other problems such as dimensional measurements on complete fuel pins or can thickness measurements. The apparatus comprises the following main parts: a vertical scanning bench; a pneumatic measuring system; electric differential manometers; and a digital data display assembly. The digital recording technique enables the measurements to be memorized for immediate or later use (comparison with post-irradiation measurements); it avoids the errors associated with the often tedious analysis of graphic documents. (auth)

6511 NONDESTRUCTIVE CONTACT-LESS MEASUREMENT OF THE DEFECTS IN FUEL ELEMENT CANS. Vozenilek, Frantisek (Inst. of Nuclear Research, Rez, Czech.); Kavan, Karel. Colloq. Met., Commis. Energ. At. (Fr.), 12th, 1968; 377-83(1969). (In French).

XUM

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. See CONF-680606.

A method for the contactless and nondestructive testing of the thickness, thickness variation and eccentricity of tube walls made of nonmagnetic materials, and for the detection of longitudinal and transversal cracks passing completely through the walls of these tubes is described. This technique has been used for the measurement of thickness variations and for the control of the quality of smooth and grooved aluminum cans taken from a few hundred fuel elements designed for increasing the power of the Czechoslovak Reactor VVR S. The measurements were carried out using eddy currents and evaluating the electric conductivity of material. The measurements described represent the nondestructive contactless measurements carried out on the nonmagnetic metallic parts of the technological circuit installations of the Czechoslovak Reactor VVR S. (auth)

6512 NEUTRON RADIOGRAPHY. Alter, H. W. Canadian Patent 849,639. 18 Aug 1970.

A method and apparatus using track-etch techniques is described. In this system, an object is placed between a neutron source and a composite consisting of a sheet of detector material and a conversion material. Neutrons passing through the object with variable attenuation cause the emission of charged particles by the conversion material which impinge on and form damage tracks in the detector sheet. The damage tracks are etched with 6N sodium hydroxide. Where neutron density is sufficient, a visible variable density, light scattering radiographic image of the object result[sic]. (F.S.A.)

6513 DEVELOPMENTAL DIRECTIONS OF AUTORADIOGRAPHY. Bartha, Laszlo (Research Inst. for Applied Physics, Debrecen, Hungary). Atomtech. Tajek.; 13: 163-9(1970). (In Hungarian).

The autoradiographic technique started with the discovery that uranium salts placed on a silver halide emulsion cause its blackening. Today interactions between ionizing particles and matter may be conveniently studied by means of special photographic emulsions. The type and energy of the particles may be determined by examining the tracks on the emulsion, while the intensity and the location of the radiation source, i.e., the number and spatial distribution of the radioactive atoms may be derived by counting the tracks or determining the darkening of the emulsion. Since Becquerel's classic discovery in 1896, autoradiography became a widely used tool in the twenties for studying biological specimens, metals, and minerals. The technique received a special impetus after World War II when artificial radioisotopes and special emulsions became available on an industrial scale. The method may be used for localizing tracers which participate in the metabolism of living organisms, for studying physical and chemical processes in solids, for determining the distribution of impurities and of surface properties, and for examining the efficiency of purification methods, such as zone melting. The study may involve direct contact, stripping of films, or use of liquid emulsions. Radiation such as α, β, γ rays, or neutron fluxes may serve as the source. The problems encountered in experimental work, including the preparation of the emulsion, are outlined. 27 references. (TTT)

Protective Structures

6514 (CEX-69.5) EXPERIMENTAL EVALUATION OF THE FALLOUT-RADIATION PROTECTION PROVIDED BY STRUCTURES IN THE CONTROL POINT AREA OF THE NEVADA TEST SITE. Burson, Zolin G. (EG and G, Inc., [Las Vegas, Nev.]. Division of Biology and Medicine (AEC), Washington, D. C.). May 1969. 120p. Dep. NTIS.

Fallout-radiation protection factors (PF's) were determined for six buildings within the CP complex of the U. S. Atomic Energy Commission's Nevada Test Site, four from experimental data with fallout simulation techniques and two derived from calculations. Data using ^{60}Co are applicable to a deposited 1-hr fission-product condition. Results are presented as PF contours on floor plans. Protection from 1-day-old fission products and from cloud passage was also estimated. These values are about the same for lightly constructed buildings (CP-14 and CP-50) but increase to as much as a factor of 3 higher for heavily constructed buildings (CP-1B). Construction of a baffle wall around the west entrance to the main floor of CP-1B and provision of sandbags or concrete blocks to block up the north entrance to the basement are recommended to significantly improve protection factors in the Test Manager's Operations Room and the downstairs briefing room, respectively. In addition to obtaining protection-factor values for the buildings of concern, the experiment yielded much valuable information useful to a variety of radiation and shielding studies. (auth)

Radioactive Material Handling

Refer also to abstracts 6473 and 6475.

6515 (BHO-66-1) PLUTONIUM PASSIVE ASSAY FACILITY PLANT INSTRUMENTATION PROGRAM. First Quarterly Progress Report, April-June 1970. Brooks, W.; Magdics, A.; Molen, G.; Rosh, D. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). 14 Aug 1970. Contract AT(30-2)-66. 25p. (UNC-5264). Dep. NTIS.

Activities directed toward evaluation of the merits of passive neutron and gamma assay of Pu fuel rods, scrap packages, and waste barrels are reported. The use of BF_3 neutron detectors and Li-drifted Ge gamma detectors are being investigated for use in the assay. System operating experience and results of data analyses are to be used in evaluation of system performance. (J.R.D.)

6516 (BNWL-CC-1546(Rev.2)) BNW MODEL 10 SHIPPING CONTAINER FOR NON-IRRADIATED FISSIONABLE MATERIAL: BASIS FOR DOT SPECIAL PERMIT. Brown, C. L.; Lawrence, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 20 Apr 1969. 14p. Dep. NTIS.

Results of drop and fire tests on this container show that transportation safety is not jeopardized by the use of plastics, wood, and similar hydrogenous materials for packing when the container is loaded. The procedure for use in changing the DOT permit is outlined. (J.R.D.)

6517 (BNWL-SA-3008) COMPUTER SIMULATION OF THE RADIOACTIVE WASTE SOLIDIFICATION PROCESS OFF-GAS SYSTEM. Owzarski, P. C.; Cole, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 11 May 1970. 13p. (CONF-700632-1). Dep. NTIS.

From Conference on Digital Simulation of Continuous Systems, Denver, Colo.

A mathematical model of the waste solidification process off-gas system, WSEP, was developed to provide a method for predicting radionuclide decontamination and the physical and chemical nature of the gas stream anywhere in the system as a function of process parameters. The digital mode, using SIMPL-1 programming on the PDP-7 digital computer, has about 30 coupled, nonlinear differential equations. This model can be coupled to an existing hybrid simulation of the condensate phase — a complex unsteady-state system of material balances. The computation techniques, theoretical bases, and computed results as compared with observed values are presented. (L.C.L.)

6518 (GEAP-12114-2) INTEGRATED SAFEGUARDS EXPERIMENT. First Quarterly Report, May-August 1970. Wadekamper, D. C.; Hagie, L. T. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Aug 1970. Contract AT(30-1)-68. 7p. (BHO-68-2). Dep. NTIS.

Work was initiated on the Integrated Safeguards Experiment during May, 1970. The program is directed toward evaluating the usefulness to safeguards of material balance techniques which employ only measured data. The available historical data are summarized, and accomplished experimental planning is defined. The first experiment was started. (auth)

6519 (IN-1433) TECHNIQUE FOR ASSAY OF L-10 BOTTLES OF PLUTONIUM NITRATE. Cline, J. E.; Nieschmidt, E. B.; Connelly, A. L.; Murri, E. L. (Idaho Nuclear Corp., Idaho Falls). Oct 1970. Contract AT(10-1)-1230. 29p. Dep. NTIS.

A technique for the assay of L-10 bottles containing plutonium nitrate has been developed. This method uses non-destructive Ge(Li) gamma-ray spectroscopy and is capable of measuring total plutonium content as well as relative abundances of the ^{239}Pu, ^{240}Pu, and ^{241}Pu isotopes. Accuracies of about 5% may be obtained for total, ^{239}Pu, and ^{241}Pu content and of about 10% for ^{240}Pu content. The assay may be performed quickly and simply by personnel of the particular fuel processing or fabricating plants. (auth)

6520 (ORNL-TM-3225) MULTIPURPOSE BUILDING FOR PROCESSING ALPHA, BETA, GAMMA, AND NEUTRON EMITTERS. Schaich, R. W. (Oak Ridge National Lab., Tenn.). Dec 1970. Contract W-7405-eng-26. 23p. Dep. NTIS.

The physical facilities, operations, and operating procedures for a multipurpose radioisotope processing building are described. (auth)

6521 (RFP-1557) GLOVEBOX FIRE TESTS. Domning, William E.; Woodard, Richard W. (Dow Chemical Co.,

Golden, Colo. Rocky Flats Div.). 6 Nov 1970. Contract AT-(29-1)-1106. 55p. Dep. NTIS.

Fire tests were performed on a shielded glovebox to determine the necessary action to minimize damage which might result from fires in such boxes. The most flammable shielding material tested was methyl methacrylate base plastic. Shielding fabricated from pressed fiberboard also burned, but it can be protected from fire by a covering of intumescent paint, stainless steel, or aluminum foil. Glovebox gloves can be protected by a device designed at Rocky Flats. Pyrex, safety glass, wired glass, and polycarbonate plastic are more suitable than methyl methacrylate for glovebox window materials. Gasket supported windows should have metal protectors for the gasket and to prevent the window from falling inward. Sprinkler heads were effective in controlling glovebox fires; however, considerable damage to the box occurred before the heads operated. Stopping glovebox ventilation was effective in controlling a fire, but this could lead to an explosion. (auth)

6522 (UCRL-72445) SHIELDED NEUTRON SHIPPING CASK. Hanson, C. L.; Coops, M. S.; Arnold, E. D. (California Univ., Livermore. Lawrence Radiation Lab.). 6 Jul 1970. 18p. (CONF-701102-4). Dep. NTIS.

From Meeting of the American Nuclear Society, Washington, D. C.

A shielded neutron shipping cask was designed to transport three-gram quantities of californium-252. The cask weighs 25 tons and may be shipped by common carrier anywhere in the United States. Neutron sources will be packaged in all-metal pressure vessels suitable for use at 1500°F. Three source vessels, each three inches in diameter by twelve inches long, may be stored in a rotating magazine at the center of the cask. An eight-foot-long plug with grapple fingers locks the magazine during transport and is also used to remotely load or unload the neutron-source vessels. A Boral plate is used to absorb slow neutrons and a steel billet provides primary-gamma shielding near the center of the cask. The neutron shield consists of borated limonite concrete and borated gypsum cast into the cavities formed by two concentric steel shells. (auth)

6523 RADIOACTIVE WASTES FROM DECONTAMINATION LABORATORIES. Raviv, Samuel (Negev Nuclear Research Center, Beersheba, Israel). Ind. At.; 14: No. 7-8, 54-60(Jul-Aug 1970). (In French).

A new method of cathodic decontamination of metals and containers contaminated by radioactive elements is presented. This method makes it possible to decontaminate metallic surfaces simply in nitric acid, even to decontaminate a surface without dismounting it, solely by applying a carefully determined cathodic density to the surface and emptying the solution under current. This process greatly cuts down the quantity of the radioactive effluents deriving from decontamination operations. Cathodic decontamination does not bring about corrosion; the dissolution is regular and homogeneous. The gases which issue in the course of this operation are N_2O, N_2 and O_2. The rate of cathodic dissolution is in direct ratio to the quantity of oxygen emitted at the cathode. This oxygen results from the electronic interaction on a double electric layer, and the O-ions induce the cathode dissolution of the metallic surface. (auth) (France)

6524 HOT LABORATORY FACILITIES. 1. THE $\alpha-\gamma$ LEAD CELL. Muramatsu, Takio; Hamano, Michio (Ebara Mfg. Co., Ltd., Tokyo). FAPIG (Tokyo); No. 57, 54-8(May 1970). (In Japanese).

The $\alpha-\gamma$ lead shielded hot cell is described, using the unit at JAERI as an example. The purpose of this cell is to handle α-emitters and gamma radiation. It consists of an α-tight box with gamma shielding surrounding the inner box. The overall dimensions of the cell are 2.6 m × 1.8 m × 1.5 m high. The α-tight box is a separation box of welded stainless steel structures; the shielding surrounding it is made of lead bricks and steel plates. The inner box is equipped with a NaK capsule opener and sample cutter. As is usual for such cells, an air conditioning system, manipulator, and tongs are also provided. (Japan)

6525 INTERNATIONAL CONTROL OF DISPOSAL OF RADIOACTIVE WASTE. Ishikawa, Shigeru (Tokyo Electric Power Co. Inc.). Genshiryoku Kogyo; 16: No 7, 32-6(Jul 1970). (In Japanese).

The regulations concerning the disposal of radioactive wastes, from the standpoint of an international law, were first taken up in a conference at Geneva in 1958. Subsequently, a series of the panel discussions in this connection were held in Vienna, followed by other similar meetings. The regulation of the contamination of oceans by radioactive wastes internationally, still depends on future developments. The discussions are included on the international attempts to control the ocean contamination by radioactive wastes, how the situation is at the present time, and other associated problems. (Japan)

6526 IMPROVEMENTS IN AND RELATING TO PROTECTIVE SHELLS FOR SHIELDING FLASKS. Lacheteau, Herve (to Commissariat a l'Energie Atomique). British Patent 1,211,999. 11 Nov 1970. Priority date 2 Oct 1968, France.

A protective shell is described which comprises a cylindrical outer container braced by parallel plate sidewalls and plate-type end pieces. The shell is thermally insulated and is provided with a disk to retain and stabilize the inner lead flask. A detachable cover is provided for access in the shell. Tie rods are provided for the flask-stabilizing disk. (J.R.D.)

6527 SOLIDIFICATION AND DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN THE UNITED STATES. Schneider, K. J. (Battelle-Northwest, Richland, Wash.). Reactor Technol.; 13: 387-415(Winter 1970-1971).

The solidification and disposal of high-level liquid wastes that result from nuclear fuel reprocessing in the U.S. are discussed in detail. The chemical and physical characteristics of such wastes are described and the quantity of high-level liquid wastes in the U.S. to the year 2000 is predicted. The solidification methods described include: pot calcination; spray solidification; phosphate glass solidification; and fluidized-bed calcination. The general characteristics of wastes obtained from each of these solidification processes are tabulated. Methods for long term disposal of solidified radioactive wastes are discussed and include disposal in salt mines, natural deep underground caverns, man-made vaults, and ocean depths. The disposal of liquid radioactive wastes in deep wells (i.e., porous underground beds interstratified with impermeable beds), in deep underground caverns, and, for short term, in underground storage tanks is considered. Of the currently practical schemes, storage in salt mines most nearly approaches ultimate disposal. Two truly ultimate disposal concepts, transmutation of long-lived radioisotopes to short-lived radioisotopes that decay to stable isotopes and transporting high-level waste to another planet, are mentioned. Finally, cost-estimate study results for processing, transporting, and storing high-level waste from reactor fuels are presented. (L.C.L.)

6528 WASTE MANAGEMENT IN FOREIGN COUNTRIES. Sakata, Sadahiro; Matsumoto, Akira; Shinji, Yoshimasa (Japan Atomic Energy Research Inst., Ibaraki). Genshiryoku Kogyo; 16: No. 7, 10-14(Jul 1970). (In Japanese).

Methods for the radioactive waste disposal used in oversea countries are described. Fixing of radioactive residues in bitumen is discussed. The method of solidifying concentrated liquid wastes in bitumen was originally developed in Mol, Belgium, and further developed in Marcoule, France, and Oak Ridge, Tenn. After describing its features, the respective techniques are explained. The disposal of specific objects, including solid wastes with α-emitters, irradiated metal specimens, disassembled parts, and plastic sheets is discussed. Underground disposal methods for dealing with high-level secondary wastes are described and include: seepage trench disposal in Oak Ridge, Tenn., ground disposal of sludges; hydrofracturing disposal in Oak Ridge to inject liquid waste with cement into the deep layer; and storage in salt mines in the US and in West Germany. (Japan)

Vacuum Engineering

6529 METHOD OF PRODUCTION OF ULTRA-HIGH VACUUM AND VACUUM PUMP FOR CARRYING OUT SAID METHOD. Prevot, Francois; Sledziewski, Zbigniew (to Commissariata l'Energie Atomique). British Patent 1,212,808. 18 Nov 1970. Priority date 25 Sep 1968, France.

The design of a high vacuum system is described. A getter-ion pump used in the ultimate pressure reduction incorporates TiO as gettering agent. The TiO is capable of absorbing rare gases as well as other gases. (J.R.D.)

XUM

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 6280, 6399, 6515, 6519, 6699, and 7851.

General Detectors and Monitors

Refer also to abstracts 6592, 6723, 6726, 7334, 8061, and 8136.

6530 (AEEW-R-698) DEVELOPMENT OF HAMMER-SWAGED TRIAXIAL MINERAL INSULATED CABLES FOR USE WITH HIGH-TEMPERATURE NEUTRON DETECTORS. McMinn, K. W. (Atomic Energy Establishment, Winfrith (England)). Oct 1970. 6p. Dep. NTIS (U. S. Sales Only).

The development of a hammer-swaged mineral insulated cable suitable for use with high temperature neutron detectors is described. Typical properties of the cable are given together with points of interest in its development. (auth) (UK)

6531 (BARC-505) OPTIMISATION OF CRYSTAL POSITIONS IN A MULTIDETECTOR-STRETCHER WHOLE-BODY COUNTING ASSEMBLY: PROGRAM OCRYSP. Hukkoo, R. K.; Unnikrishnan, K. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 38p. Dep. NTIS (U. S. Sales Only).

A semi-empirical method is proposed to arrive at the best configuration of detectors for a multidetector-stretcher geometry for whole-body counters. The summed response of the geometry is predicted over the desired length of the stretcher and various criteria applicable to minimize the variation are discussed. (auth)

6532 (BNWL-SA-3365) NEUTRON SENSITIVE CRITICALITY DETECTION SYSTEM. Friend, P. C.; Ratcliffe, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [nd]. Contract AT(45-1)-1830. 8p. (CONF-701109-2). Dep. NTIS.

From IEEE Nuclear Science Symposium, New York, N. Y.

An improved alarm system to detect and warn against uncontrolled nuclear criticality events has been developed for the Hanford site. The system is neutron sensitive with an alarm threshold of 8 millirad/hour of "steady" neutron irradiation or 4 microrad of pulsed radiation. Redundancy techniques and self-check features have been incorporated whenever possible to enhance operational reliability. (auth)

6533 (BNWL-SA-3397) COMPARISON OF GERMANIUM AND SODIUM IODIDE IN VIVO MEASUREMENT SYSTEMS. Andersen, B. V.; Bramson, P. E.; Unruh, C. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1970]. Contract AT(45-1)-1830. 19p. (CONF-701112-1). Dep. NTIS.

From Symposium on New Developments in Physical and Biological Radiation Detectors, Vienna, Austria.

Lithium-drifted germanium (GeLi) and lithium-drifted silicon (SiLi) counting systems for in vivo measurements are compared with conventional scintillator detector systems in similar configurations. Measurements of plutonium and americium in lungs, other organs, and wounds using coaxial and planar drift detectors are presented. A proposed large area planar Ge(Li) lung counter system is compared to 2 and 4 crystal sodium iodide counters (130 cm^2 by 9 mm thick) currently used for uranium and plutonium lung measurements. A large Ge(Li) detector system being employed at Battelle-Northwest Laboratory to make whole body measurements of radionuclide depositions in humans consists of four coaxial detectors each 40 cm^3 in volume for a total of 160 cm^3. The individual detectors are enclosed in separate cryostats but mounted in a common 30 liter liquid nitrogen dewar of the "chicken feeder" design. The system is compared to the standard 23 cm diameter by 10 cm thick sodium iodide scintillator in the standard chair position. (auth)

6534 (CEA-CONF-1642) CHARGED PARTICLE DETECTORS MADE BY IMPLANTATION. Garin, A.; Waast, B. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Oria, M. (Institut National des Sciences et Techniques Nucleaires, Saclay (France)). 1970. 5p. (CONF-700544-1). Dep. NTIS (U. S. Sales Only).

From International Conference on Ion Implantation in Semiconductors, Thousand Oaks, Calif.

Ion implantation was considered as a way of doping detectors. The possibilities of implanting phosphorus and boron ions in silicon for dE/dx and localization detectors and lithium ions for deep E detectors were studied. It is possible to make thick NIP detectors which have neither front nor back window and which can be stacked for measuring particles of very high energy. (France)

6535 (CNEA-262) CORRECTIONS FOR DEAD TIME IN DETECTION EXPERIMENTS ON NUCLEAR STATISTICS. Madero, C. Castro; Corcuera, R.; Schilman, H. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1969. 16p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Corrections for the dead time to be used in nuclear detection experiments were obtained. A probability analysis of the problem was made beginning with the possible distinct states in a detection system. The correlations of states of the system, responsible for the loss of counts, are corrected comparing the probabilities of the distinct stages. The formalism is then applied to the two most important statistics in nuclear detection: Poisson statistics and binominal negative statistics. Its application to some experiments, such as that of neutron correlation, is immediate. The precision of the expressions obtained was verified experimentally in studies on the Poisson distribution. The χ^2 test showed the present formulation to be more exact than that of Pacilio. The p correction parameter was determined experimentally for a large number of conditions and the results show the validity of the theoretical hypotheses. (tr-auth)

6536 (JAERI-Memo-4144) PULSE-PILEUP EFFECT IN NaI(Tl) DETECTOR SYSTEM. Sekine, Toshiaki; Baba, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Sep 1970. 20p. (In Japanese). Dep. NTIS (U. S. Sales Only).

A method for estimating the pulse-pileup effect is presented. It is shown that the analysis can be carried out in terms of the peak-area ratio between two γ-ray sources of the same nuclide with different intensities, measured at the same geometry. The deviation of the photopeak area by the pulse-pileup effect in a NaI(Tl) detector was estimated for the γ ray from the ^{137}Cs source (0.662 MeV). The deviation was proportional to the total counting rate and the four-tenths power of the time constant of an amplifier. (auth)

6537 (LYCEN-7049) USE OF THE CAE 90 10 COMPUTER WITH THE LYON SYNCHROCYCLOTRON. DEVELOPMENT OF A SYSTEM FOR ACQUIRING DATA AND IDENTIFYING PARTICLES. Rebouillat, Marc (Lyon Univ. (France). Institut de Physique Nucleaire). Jun 1970. 74p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A multichannel input data acquisition assembly capable of identifying particles on two channels is studied. A single converter with a multiplexed input was used; in this way, the problems due to differences between converter response curves (converter slope and linearity) were avoided; this system is less expensive than a system using a converter at each channel. The equipment developed presented to the computer a normal peripheral unit, in spite of the random manner in which the information was received. The Goulding system was retained to identify the particles. The path R of a particle of energy E is given by the empirical formula $R = a.E^b$ (a is a constant characteristic of the type of particle considered and b lies between 1.7 and 1.8). The energy loss $\Delta E = E - E_2$ and the final energy E_2 were measured. This information was digitized during the data acquisition sequence and the identifications parameter subsequently obtained in two operations: the raising to the power b of the quantities E and E_2 and the subtraction $E^b - E_2^b$. The CAE 90 10 computer was fed with information received from a small auxiliary computer whose principal elements were the E^b and the subtracters. (France)

6538 (UCRL-19530, pp 329-39) ELECTRONIC INSTRUMENTATION AND SEMICONDUCTOR DEVICES. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

Topics include input charge digitization in nuclear-event-sensitive amplifiers, data link between PDP-9 and CDC-6600, recent results on the optoelectronic feedback preamplifier, recent observations on the Fano factor in germanium, selection of germanium for lithium-drifted radiation detectors by observation of etch-pit distributions, and thin-window germanium detectors: fallacy and fact. (W.H.K.)

6539 METHOD OF MEASURING THE CONCENTRATION OF FREE ATOMS OF THE DECAY PRODUCTS OF EMANATIONS IN AIR BY MEANS OF DIFFUSION BATTERIES. Polev, N. M.; Ruzer, L. S. This paper was summarized in At. Energ. (USSR); 25: 227-8(Sep 1968) as paper No. 231. (In Russian).

A method using diffusion batteries is described whereby the proportion of free atoms in the total concentration of radioactive aerosols of the radon decay products can be determined. Results

of the method for measuring the proportion of free polonium-218 atoms under laboratory conditions are described. (W.H.K.)

6540 SEMICONDUCTOR DEVICE FOR DETECTING AND/OR MEASURING RADIATION. Hornstra, Jan; van Dantzig, Rene; Oosthoek, Dirk Pieter (to Philips Corp.). U. S. Patent 3,529,159. 15 Sep 1970. Priority date 1 Mar 1966, Netherlands.

A semiconductor detector employing a single crystal disc of semiconductor material having a diamond crystal structure, wherein the crystal is cut such that the normal to the disc is oriented, within 5°, in an irrational direction which deviates by an angle of 1° from the [432]-direction towards the [111]-direction is described. (auth)

6541 MULTIPLE SEMI-CONDUCTOR RADIATION DETECTORS WITH COMMON INTRINSIC REGION. Kraner, Hobart W. (to United States Atomic Energy Commission). U. S. Patent 3,527,944. 8 Sep 1970. Filed 10 Oct 1968.

A lithium drifted germanium gamma ray detector to eliminate unwanted Compton interactions having an outer doped region with spaced contacts and grooves separating said contacts from electrical connection is described. In one form a common doped contact is separated from the spaced contacts by the intrinsic region. Incomplete Compton interactions appear randomly and singly on the spaced contacts and can be eliminated. Multiple Compton interactions in which the full gamma energy is absorbed appear as coincident pulses which are passed for spectral analysis. (auth)

6542 RESPONSE OF NE 218 TO FAST NEUTRONS. Masterson, T. G. (Univ. of Wisconsin, Madison). Nucl. Instrum. Methods; 88: 61-3(1970).

The relative light output of an Ne 218 scintillator was compared for low energy gamma rays and for neutrons in the energy range 1.4 to 30 MeV. (auth)

3543 MEASUREMENT OF THE NEUTRON FLUX IN THE ENERGY RANGE BETWEEN 10 keV AND 1 MeV BY THE MANGANESE BATH METHOD AND APPLICATION TO THE CALIBRATION OF A COUNTER. Leroy, J. L.; Huet, J. L.; Gentil, J. (Departement de Recherche Physique, Cadarache, France). Nucl. Instrum. Methods; 88: 1-11(1970). (In French).

The neutron flux emitted from the target of a Van de Graaff accelerator has been determined in the neutron energy range of 10 keV to 1 MeV, using the manganese sulfate bath method with a collimated geometry. The obtained accuracy is ±1.8%. This method has been used to calibrate the so called "directional long counter". This device is normally used for neutron standardization, in cross section measurements. The response of this counter has also been computed by Monte Carlo, and is almost independent of energy in this range. (auth)

6544 INFLUENCE OF THE DIFFERENT TYPES OF GELATIN ON THE SENSITIZATION OF IONOGRAPHIC EMULSIONS BY TRIETHANOLAMINE. Zizic, B.; Demers, J.; Demers, P. (Univ. of Montreal). Nucl. Instrum. Methods; 88: 29-32(1970). (In French).

The efficiency of triethanolamine as a sensitizer of ionographic silver-bromide-gelatine detectors has been studied under the variation of several factors imposed upon the liquid emulsion: gelatin type and treatment, water quality and quantity, and duration of washing. (auth)

6545 NOVEL DRY PLATE FOR RECORDING ENERGETIC PARTICLE BEAMS. Nakai, A.; Ishikawa, T. (Electrotechnical Lab., Tokyo). Nucl. Instrum. Methods; 88: 65-8(1970).

A silver coated graphite plate is proposed for recording of the beam intensity distribution of energetic particles. The principle of recording is based on the sputtering of silver by the incident particles. The plate can clearly record beam profiles over a wide range of the beam intensity. The recorded beam intensity distribution can be analyzed quantitatively by measuring the intensities of the light reflected from the plate surface as it is exposed to suitable sources of light. The plate can be used for any sort of beams and it can be easily prepared in the laboratory. Some examples of beam recording in the electromagnetic isotope mass separator are shown. (auth)

6546 STEEL-SCINTILLATOR COUNTER TO DETECT NEUTRONS. Marshak, M. L.; Schmueser, P. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods; 88: 77-82(1970).

A steel-scintillator sandwich counter was used as a simple and highly efficient detector for both neutrons and protons. The validity of simple approximations for the detection efficiency was investigated by experimental tests and a detailed Monte Carlo calculation of the nuclear and electromagnetic cascades in the counter. (auth)

6547 DESIGN OF A 512,000 CHANNEL BIDIMENSIONAL ANALYZER USING AN IBM 1800 COMPUTER. Gonidec, J. P. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods; 88: 125-35(1970). (In French).

A 512 000 channels addressable analyser is designed for multiparameter experiments. The disk unit of an IBM 1800 computer is used as a memory: a disk word location represents an (X,Y) event, its content gives the repetition of this event during the experiment. The sharing and executive program and the bidimensional analysis of a complex decay scheme in ^{28}Si are described. (auth)

6548 INVESTIGATION OF SOME PROPERTIES OF MULTIWIRE PROPORTIONAL CHAMBERS. Bouclier, R. (CERN, Geneva); Charpak, G.; Dimcovski, Z.; (and others). Nucl. Instrum. Methods; 88: 149-61(1970).

This article describes a systematic study of the efficiency, space resolution and multiparticle separation in multiwire proportional chambers. For a variety of gas mixtures, results were obtained as functions of high voltage, time resolution and incidence angle of particles. A new gas, argon + isobutane + freon-13 B1 permits a considerable gain in amplification without entering into the Geiger or spark region. (auth)

6549 NUCLEAR REACTION MEASUREMENTS WITH ^{1}H, ^{2}H, ^{3}He, AND ^{4}He INCIDENT ON SILICON DETECTORS. King, T. R.; Kraushaar, J. J.; Ristinen, R. A.; Smythe, Rodman; Stupin, D. M. (Univ. of Colorado, Boulder). Nucl. Instrum. Methods; 88: 17-27(1970).

Nuclear reactions which occur when a lithium-drifted silicon detector is bombarded with beams of 15.1, 21.6, and 26.5 MeV protons, 17.0 MeV deuterons, 40.7 MeV ^{3}He ions, and 33.6 MeV alpha particles have been observed. The energies and intensities of a number of reaction peaks were measured. A calculation is described which predicts quite accurately the energy and intensity of several of the observed reaction peaks. The calculation is based on previously measured reaction cross-sections, together with a theory for the sharing of nuclear recoil energy between atomic and electronic processes. (auth)

6550 PLASMA EFFECTS IN SEMICONDUCTOR PARTICLE DETECTORS. I. Makovskii, L. L. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 3: 631-3(Nov 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 744-7(May 1969).

Planar and cylindrical track models are used to show that allowance for the diffusion in the presence of plasma effects can reduce considerably the calculated charge collection time. (auth)

6551 DETECTOR SHIELDING FOR THE MEASUREMENT OF TOTAL NEUTRON CROSS-SECTION AT BACKWARD ANGLES. Hussain, M. (Dacca Univ., Pakistan); Husain, S.; Islam, E.; (and others). J. Nucl. Energy; 24: 385-6(Nov 1970).

The detector shielding described was designed to obviate high background counts when measuring total cross-sections at lower energy ranges. It was tested and found to be insensitive to neutrons of energy <1 MeV and to gamma rays. The signal to noise ratio, i.e., the ratio of direct neutron counts to background counts, was 30 for both T(d,n) and D(d,n) reactions which gave neutrons of ~13 MeV and 2 MeV resp., compared with ~4 or 5 for the T(d,n) reaction without shielding. Total cross-section measurements for ^{55}Mn, ^{127}I, and ^{141}Pr at 13.36 MeV and 13.48 MeV showed reasonable agreement with values determined by other workers. (UK)

6552 A ^{232}Th MINIATURE FISSION COUNTER FOR FAST NEUTRON FLUX MEASUREMENTS. Kato, Hidemasa (Hitachi Ltd., Japan). Nippon Genshiryoku Gakkaishi; 12: 570-6(1970). (In Japanese).

A ^{232}Th miniature fission counter probe was perfected with use of the Th depositing technique. A sensitivity of approximately 1×10^{-6} counts/n/cm^2 was obtained for reactor fast neutron flux with a typical cylindrical counter (6 mm O.D., 10 mm sensitive length). The counter was applied to the measurement of the fast neutron flux distribution within a research reactor core. The fast neutron flux distribution thus measured with the counter provided results identical with that obtained from the activation of threshold foils. Depleted U fission counters with Cd cover have in the past been used for fast neutron flux measurements. The ^{232}Th fission counter can, however, be used without Cd filter, with excellent resolution of thermal and epithermal neutrons. (auth)

6553 ELECTRONIC COLLIMATION IN PROPORTIONAL COUNTER BY RISE TIME DISCRIMINATION. Mizuho, Mitsuru; Mizoguchi, Tadanori (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo); 7: 335-40(Jul 1970).

A method of electronic collimation in a proportional counter was

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developed and its performance examined. The method utilizes the difference in the rise time of output pulses. The rise time is converted into pulse height by using a rise-time-to-pulse-height converter, followed by a single channel pulse-height analyzer. Choosing the pulses of the fastest rise time, one can selectively register the energies of the particles parallel to the center wire (anode). The method is applicable to gas-recoil fast-neutron spectrometers. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 6590.

6554 (IKF–26) Ge(Li)-NaI(Tl) PAIR SPECTROMETER. Hanle, H.; Stelzer, K.; Koriath, M.; Krueger, H. (Frankfurt Univ. (West Germany). Institut fuer Kernphysik). Sep 1970. 37p. (In German). Dep. NTIS (U. S. Sales Only).

By the use of a pair spectrometer the complex spectra of high-energy γ-rays can be simplified appreciably. The pair spectrometer described in this report consists of a small Ge(Li)-detector and a NaI(Tl)-annulus which is divided into four equal sectors. The annulus has a length of 12.5 cm and an outer diameter of 16.5 cm. The performance of this spectrometer has been investigated with sources of ^{24}Na and ^{226}Ra in different combinations of the sectors. (auth)

6555 PEAK FINDING METHOD FOR USE IN Ge(Li) SPECTRA PROCESSING. Kosina, Z. (Nuclear Research Inst., Prague). Nucl. Instrum. Methods; 88: 163-4(1970).

The present method is based on elimination of background by subtracting a smoothed spectrum from the original one. As a result it provides the first guess values of peak positions and intensities for a conventional least-squares-fit procedure. (auth)

6556 IMPROVEMENT OF SIGNAL-TO-NOISE RATIO IN NUCLEAR RADIATION SPECTROSCOPY WITH SEMICONDUCTOR DETECTORS BY PULSE COMPENSATION. Schuster, H.-J. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods; 88: 119-23(1970). (In German).

The signal-to-noise ratio in high resolution pulse-amplitude spectrometry is not only limited by noise currents and noise voltages but also by the pile up effect. Especially at high pulse rates and large amplitudes it is mainly determined by the pile up effect. In this case the signal-to-noise ratio can be improved by measuring a selected number of all pulses only. The other pulses are compensated in order to reduce their contribution to the signal-to-noise ratio. The pulses to be measured may for example be selected by coincidence- or amplitude-restrictions. In principle the best possible signal-to-noise ratio can be obtained in this way. (auth)

High Energy Physics Instrumentation

6557 (CERN-Trans–70–8) MATCH TEST AND DEVICE REQUIREMENTS FOR A METHOD OF SUPERIMPOSING THE PROJECTION OF A TRAJECTORY ON TO A TRACK. Sokolov, S. N.; Utochkin, B. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by R. Luther (CERN, Geneva, Switzerland), from report IFVE-SVM-SEF–69–27. 21p. Dep. NTIS (U. S. Sales Only).

Match tests and device requirements for bubble chamber particle track analysis system are discussed. Topics include the strict match test, match test for one track, the masking method, the least squares method, match test on the frame plane, match test for a stereoscopic photograph, effects of photography, principles for carrying out match test, and requirements for a device designed to analyze the degree of match. (W.H.K.)

6558 (IFVE-SEF–69–72) INVESTIGATION OF THE DEPENDENCE OF THE SPARK BRIGHTNESS OF IONIZATION IN THE RANGE OF $1 \leq I/I\ MIN \leq 15$ AT P = 1 atm., 0.3 atm., 0.1 atm. Bolotov, V. N.; Bydanov, G. A.; Devisheva, M. N.; Devishev, M. I.; Michailov, O. I.; Karpov, I. I.; Semenov, V. K. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 32p. (In Russian). Dep. NTIS (U. S. Sales Only).

The spark brightness has been studied in a wide range of ionization bases at P = 0.1 atm., 0.3 atm., 1 atm. It is shown, that: (1) dependence of the brightness on the ionization is of logarithmical characters at various pressures; (2) the range and the degree of the brightness dependence on ionization is determined by the choice of the operational mode of the chamber H. V. supply; and (3) the distribution of the ionization losses, measured experimentally with respect to the spark brightness, coincides for the particles with the same energy. (auth)

6559 (JINR–P13-5291) INVESTIGATION OF THE HYDRODYNAMICAL PROCESSES AND THE PARAMETERS OF THE GLASS MOTION IN A LARGE BUBBLE CHAMBER. Lomakin, Yu. F.; Chvartatsky, R. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

A general investigation is performed of the homogeneity of the pressure field in the working liquid of a large bubble chamber with a "floating" glass partition that separates two different liquids in the chamber. The parameters of the glass motion necessary for calculation of the glass strength and for estimation of the optical distortions are determined. (auth)

6560 (MIT–2098–660) PROCEEDINGS OF THE SECOND INTERNATIONAL COLLOQUIUM ON PEPR, CAMBRIDGE, MASSACHUSETTS, MAY 5–7, 1970. Watts, Terence L. (ed.) (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Contract AT(30-1)-2098. 414p. (CONF-700519). Dep. NTIS.

Separate abstracts were prepared for 16 of the 17 papers presented. The remaining paper was previously included in NSA as 24: 33935. (W.H.K.)

For abstracts of individual papers see: 6561 through 6576.

6561 (MIT–2098–660, pp 9–26) STATUS OF THE YALE PEPR SYSTEM. Bogert, D.; Lucas, P.; Lund, W.; Taft, H. (Yale Univ., New Haven, Conn.).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

Achievements and developments with the Precision Encoder and Pattern Recognition (PEPR) system at Yale University are discussed. A report on physics measurements and plans for the future is given, and engineering problems and developments accompanying the conversion of the Yale PEPR hardware to the 80 inch BNL film format are described. (W.H.K.)

6562 (MIT–2098–660, pp 27–34) NIJMEGEN PEPR: STATUS. Crijns, F. J.; Deery, B. J.; Hendriks, J. H.; Holdampf, E. A.; Raaijmakers, M. C.; Schotanus, D. J.; Schouten, T. E.; Timmermans, J. J.; Van der Walle, R. T.; Warszawer, T. N. ([Nijmegen Univ. (Netherlands)]).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The present status and future plans for the PEPR project at Nijmegen University are briefly discussed. (W.H.K.)

6563 (MIT–2098–660, pp 37–75) HEIDELBERG AUTOMATIC RECOGNITION OF BUBBLE CHAMBER EVENTS. Erbe, R.; Keppel, E.; Kropp, D. (IBM Scientific Center, Heidelberg (West Germany)); Klein, F.; Reiss, G.; Schmidt, R.; Schneider, H. (Heidelberg Univ. (West Germany). Institut fuer Hochenergiephysik).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The development of a PEPR device at Heidelberg University for automatic bubble chamber film analysis is described. (W.H.K.)

6564 (MIT–2098–660, pp 76–84) TALK AT PEPR COLLOQUIUM. Martin, H. J. ([Indiana Univ., Bloomington]).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The PEPR system at Indiana University is described. Installation, operation status, current experimental plans and projected timetable for processing data on PEPR, and some details of the software system are discussed. (W.H.K.)

6565 (MIT–2098–660, pp 85–90) STATUS OF MARYLAND PEPR. Day, T. B.; Glasser, R. G. ([Maryland Univ., College Park]).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The PEPR system at Maryland University with a PDP-10 computer and CRT display is briefly described. (W.H.K.)

6566 (MIT–2098–660, pp 92–106) JOHNS HOPKINS PEPR SYSTEM. Chatzky, Carl ([Johns Hopkins Univ., Baltimore, Md.]).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The Sigma-7 computer and Astrodata PEPR system at Johns Hopkins University is described. The scope display, film transport system, program flow and operator intervention, fiducial finding routine, area scan, preliminary track following, and the vertex calculation are briefly discussed. (W.H.K.)

6567 (MIT–2098–660, pp 107–12) RUTGERS PEPR. Piano, R. J. (Rutgers–The State Univ., New Brunswick, N. J.).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The status of the PDP-6 computer and PEPR systems at Rutgers University is briefly described. (W.H.K.)

6568 (MIT–2098–660, pp 114–62) STATUS OF THE VISUAL TECHNIQUES LABORATORY. Bastien, P. L.; Dunn, L. A.; Kenyon, R. G.; Kirkpatrick, L. D.; Lubatti, H. J. (Washington Univ., Seattle. Visual Techniques Lab.).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The development of the PDP-10 computer and PEPR system at the University of Washington is described. The vertex guidance system is described including basic global transformations, the current program, performance of the program on 98 events, and the latest improvements. (W.H.K.)

6569 (MIT–2098–660, pp 163–73) COUNTER CONTROL OF BUBBLE CHAMBER PHOTOGRAPHY. Pless, I. A. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The development of a system of detectors to selectively control the picture taking in a bubble chamber so that only particle events are recorded is described. The beam is focused through a detector and anticoincidence detector at the inlet to the bubble chamber; and if no particle is detected in the semiconductor detector located inside the bubble chamber, then the picture is taken. (W.H.K.)

6570 (MIT–2098–660, pp 175–90) STATUS OF MIT's PEPR's. Bastien, P. L.; Baumel, H.; Chien, W.; (and others) (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The operation of the PEPR film processing system at MIT is briefly described, and a method for measuring the ionization of detected particles is outlined. (W.H.K.)

6571 (MIT–2098–660, pp 191–220) AUTOMATIC SCANNING AND MEASUREMENT OF BUBBLE CHAMBER FILM ON POLLY II. Allison, W. W. M.; Beck, F.; Hodges, D.; Loken, J. G.; Musgrave, B. Phillips, H. B.; Royston, R.; Sunde, R. A. (Argonne National Lab., Ill.).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

An exposure of 600,000 hydrogen bubble chamber pictures of 2.3 GeV/c $\bar{p}p$ interactions in the 30-inch Argonne MURA chamber is being scanned and measured for 2, 4, 6, and 8 prong interactions by POLLY II, a computer-controlled CRT device. The performance of the automatic scanning and measuring is assessed on the basis of the first 160,000 events processed. The control program searches for beam tracks and finds interactions without prescanning. It digitizes the tracks, measures bubble density, and outputs master point information ready for direct input to the geometrical reconstruction program. The operator is an integral part of the system and is available to give assistance when required. Film is processed at 70 to 100 events per hour. (auth)

6572 (MIT–2098–660, pp 222–49) OXFORD PEPR SYSTEM. Berge, J. P.; Harris, J. F.; Loken, J. G. (Oxford Univ. (England). Nuclear Physics Lab.).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The performance of the PEPR system at Oxford University in measuring some 13,000 π^-p 2 prong events in the Saclay 80-cm chamber is discussed. With zone guidance of 4 × 4 mm on a single view the system measured events at an average of 150 events/hour with on-line operator helping. Working with the vertex predigitized to 1 mm on a side view, and anti-selecting at the scan table events with a confused beam, the current system measures at 400 events/hour without operator assistance. (W.H.K.)

6573 (MIT–2098–660, pp 250–73) OXFORD PEPR HARDWARE. Brooks, C. B.; Davey, P. G. (Oxford Univ. (England). Dept. of Nuclear Physics).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

Oxford PEPR I design modifications are outlined including improvements in CRT performance, the light servo, and the tv system. Essential features of PEPR II are discussed including the 9-inch CRT and optics and the signal processor. (W.H.K.)

6574 (MIT–2098–660, pp 347–66) BRANCH OFF THE PEPR TREE. Fortney, Lloyd R. (Duke Univ., Durham, N. C. Dept. of Physics).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

RIPPLE, a new automatic measuring device for bubble chamber film which incorporates features of both PEPR and POLLY systems is described. RIPPLE employs a precision cathode ray tube with a polar sweep. Hit detection and software considerations are discussed. (W.H.K.)

6575 (MIT–2098–660, pp 383–402) PROGRAM TO MATCH BUBBLE CHAMBER TRACKS IN SPACE. Bastien, Pierre L. (Washington Univ., Seattle. Visual Techniques Lab.); Pless, Vera (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.); Snyder, James N. (Illinois Univ., Urbana. Dept. of Computer Science).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

A computer program, MATCH, is described for the reconstruction in space of bubble chamber particle tracks in three views. The efficiency of the program is approximately 98% on any topology, and the running time is a little over two seconds per event on an IBM 360-65 computer. (W.H.K.)

6576 (MIT–2098–660, pp 403–11) PHILOSOPHY OF A THREE-VIEW PEPR. Snyder, J. N. (Illinois Univ. [Urbana]).

From Proceedings of the second international colloquium on PEPR, Cambridge, Massachusetts, May 5–7, 1970.

The theory for development of a PEPR system for three-view analysis of bubble chamber particle tracks is described. Ideally, the three-view geometry is reconstructed by the MATCH program. Expected problems are discussed. (W.H.K.)

6577 HIGH RESOLUTION CHERENKOV CHAMBER. Giese, R.; Gildemeister, O.; Paul, W.; Schuster, G. (Univ., Bonn). Nucl. Instrum. Methods; 88: 83-92(1970).

A focusing type of Cherenkov chamber is described, in which an image intensifier is used to record the ring images. A test experiment with 16 GeV/c pions at the CERN proton synchrotron has demonstrated that the velocity resolution is $\delta\beta = 6 \times 10^{-7}$ for single pions. The precision in determining the mean velocity of the particle beam is limited by a systematic error $\delta\beta = \pm 2 \times 10^{-7}$. From the results of this experiment, it can be concluded that a similar chamber should distinguish protons and kaons of equal momentum up to 200 GeV, with high counting efficiency and an angular acceptance of 5 mrad. (auth)

6578 DETECTION AND ENERGY MEASUREMENT OF ELECTRONS ABOVE 1 GeV IN A MULTIPLATE SPARK CHAMBER. Agrinier, B. (Centre d'Etudes Nucleaires, Saclay, France); Koechlin, Y.; Parlier, B.; (and others). Nucl. Instrum. Methods; 88: 109-18(1970).

The response of a multiplate spark chamber to electron shower events has been investigated, for primary electron energy in the range 1 to 14 GeV, with exposures to momentum analyzed beams at the DESY electron-synchrotron and at the proton-synchrotron of CERN. The detector discrimination properties between electron showers and nuclear interactions are discussed; experimental relations are given between the shower image brightness, measured photometrically, and the energy of the primary electron. (auth)

6579 BALLOON BORNE DETECTOR TO DETERMINE HIGH ENERGY NEUTRONS IN ENERGY AND DIRECTION. Heidbreder, E.; Pinkau, K.; Reppin, C.; Schoenfelder, V. (Max-Planck Institut fuer Physik und Astrophysik, Garching, Ger.). Nucl. Instrum. Methods; 88: 137-47(1970).

A balloon borne experiment for the measurement of solar and atmospheric neutrons in energy and direction above 50 MeV is described. The principle of measurement is the double elastic scattering process of the incoming neutrons with hydrogen atoms. For the registration of the recoil protons spark chambers are used. The hydrogen is contained in thin plastic scintillator and polyethylene plates, which are inserted between the spark chambers. The sparks are recorded photographically from two sides. A detailed description of the design of the experiment is given. The properties of the apparatus were determined by atmospheric neutron measurements at ground level. (auth)

6580 SPARK CHAMBERS. Loebinger, F. K. (Univ. of Manchester, Eng.). Sci. Progr. (Oxford); 58: 459-79(1970).

The operational principles involved in the use of spark chambers as detectors are reviewed, and the different variations which have been developed are described. The role of these detectors in particle physics is briefly discussed. A short history of their development is given, together with speculations on their future. (UK)

Radiation Dosimeters

Refer also to abstracts 6474, and 6690–6692.

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6581 (JAERI-Memo-4121) DEVELOPMENT OF IRRADIATION TECHNICS. II. DOSIMETRY OF LARGE RADIATION SOURCES BY POLYMETHYLMETHACRYLATE. Tanaka, Ruichi; Mitomo, Shoichi; Oshima, Yunosuke (Japan Atomic Energy Research Inst., Tokyo). Aug 1970. 21p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Solid state dosimetry using radioinduced optical changes at the neighborhood of 290 mμ of commercial clear polymethylmethacrylate (PMMA) has been investigated for the purpose of development of a routine dosimetry system for high absorbed doses of both gamma rays and high energy electron beams. It is found that the optical density change is linear to absorbed dose between 0.1 and 2.5 Mrad, and that optical density change per unit dose for gamma rays is almost the same as for electron beams. The optical density increases for several hours after irradiation and then decreases slowly at any wavelength under 315 mμ, but it is nearly constant within 5 to 30 hours after irradiation. For the post-irradiation behavior, temperature effect and photosensitivity effect due to oxygen diffusion were observed, and the effect of polymerization initiator and residual monomer may be important. The good points of the PMMA dosimeter are that the measurement method is simple, the size is small, and it is applicable to gamma rays, x rays, and electron beams, but for practical absorbed measurements of irradiated media, suitable corrections for each condition of the measurements should be taken into consideration. (auth) (Japan)

6582 EQUIVALENT ENERGY OF 2 AND 3 kVp X-RAYS. Barber, D. E. (Univ. of Minnesota, Minneapolis). Health Phys.; 19: 580-2(Oct 1970).

Photographic film was used to measure the attenuation in vinylidene chloride (Saran wrap) of x-rays generated at 2 and 3 kVp to characterize the energy of a low energy x-ray beam preliminary to dosimetry measurements. These data provide a basis for determining the equivalent energy of the x-ray beams by comparison with the attenuation coefficients in Saran already reported (Henke, B. L. et al., 1964). (auth) (UK)

6583 PERFORMANCE OF GLASS AND FILM DOSIMETERS IN PERSONNEL MONITORING. Yokota, Ryosuke; Muto, Yuhei; Miyake, Toshio (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 7: 518-21(Oct 1970).

A dosimetry test under pseudo-practical conditions was carried out for a period of 1 year for the purpose of comparing the performances of photoluminescent glass and film dosimeters under Japanese climatic conditions. The results definitely proved the glass dosimeter to be far more reliable than the film dosimeter. (auth)

Radiometric Instruments

6584 (NYO-4071-1) DEVELOPMENT AND TESTING OF ISOTOPIC SHOCK-WAVE POSITION SENSOR. Final Report. Scheiwe, John P.; Cressman, David E. (Industrial Nucleonics Corp., Columbus, Ohio). 5 Jun 1970. Contract AT(30-1)-4071. 188p. Dep. NTIS.

This report presents a discussion of the design and test of a nucleonic shock-wave position sensor. The design incorporated three ^{85}Kr radiation sources and three ionization chamber detectors to measure the air density upstream of, through and downstream of the shock wave. The upstream and downstream measurement were used to eliminate sensitivity to Mach number and total static pressure changes. The results of two test programs, which demonstrated the sensitivity of the system to shock-wave position, are shown. Bremsstrahlung crosstalk and calibration were two problems encountered, and the methods which were used and are proposed to eliminate these problems are discussed. (auth)

6585 (ORO-3604-6) DENSITY DETERMINATIONS USING A GAMMA RADIATION ATTENUATION TECHNIQUE. Fourth Annual Progress Report. Dillon, I. G. (Tuskegee Inst., Ala. School of Engineering). 30 Sep 1970. Contract AT(40-1)-3604. 31p. Dep. NTIS.

The development of a gage for measuring the density of alkali metal vapor or liquid is described. A 2150 C cesium-137 gamma source and a thallium-activated sodium iodide scintillation detector with a 400 channel analyzer are used. (W.H.K.)

6586 DESIGN AND USE OF A GAMMADENSIMETRY BENCH FOR CORE SAMPLES AT THE LABORATOIRE DE GEOLOGIE MARINE OF NANTES. Ottmann, Francois (Laboratoire de Geologie Marine, Nantes, France); Courtois, Guy. Cah. Oceanogr.; 22: 815-25(Sep-Oct 1970). (In French).

A description of the apparatus is followed by a description of the measurement equipment, the choice of source (^{133}Ba), and the calibration and practical use of the bench. To interpret the gammadensimetry results, the γ curve is superimposed on suitably matched radiographs, carried out on the same scale. This 3.30 m bench is well adapted to the problem of long core-samples and it is inexpensive, since it uses standard measurement equipment. (France)

Miscellaneous Instruments and Components

Refer also to abstracts 6488, 6489, 6505, 6538, 6609, 7067, 8044, and 8121.

6587 (JUL-695-PP) DIGITIZING SYSTEM FOR FAST ANALOG SIGNALS. Hopmann, W.; Huettemann, P. W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Sep 1970. 28p. Dep. NTIS (U. S. Sales Only).

Rapid events occurring in pulsed experiments, for example in Plasma physics, produce an instantaneous high rate of information to be stored in a computer memory. To overcome the limitations imposed by the memory cycle time and also to get an ADC for broadband signals, a charge storage tube system has been developed. The difficulty arising from the different shapes of the read-out signal when the reading beam crosses the written trace at various angles has been overcome by integration of the read-out signal and determining the point when the half-height of the integrated signal is reached. Using commercial available tubes, a time resolution of better than 1% in the measuring time length with an accuracy of ~1% was achieved. Full scale step signals with a rise time of 100 nsec can be processed. Details of the system are described. (auth)

6588 (ORNL-4439) TESTING OF CERAMIC INSULATOR COMPACTION IN SHEATHED THERMOCOUPLES. Carr, K. R. (Oak Ridge National Lab., Tenn.). Dec 1970. Contract W-7405-eng-26. 38p. Dep. NTIS.

Two improved methods (direct measurement and liquid absorption) were developed for measuring ceramic insulator compaction in sheathed thermocouples. These methods were developed after tests of two methods (dye penetration and helium flow) widely used in the industry showed them to be not suitable. Thermocouple materials from 15 manufacturers were tested to evaluate all four methods. Although both the direct measurement method and the liquid absorption method, with kerosene as the absorbed liquid, are a satisfactory means of measuring the compaction of magnesium oxide insulation in sheathed thermocouples as small as $\frac{1}{16}$ in. OD, the liquid absorption method is superior. Its accuracy is ~±2% maximum theoretical density (100% MTD is 3.58 g/cm^3, the density of a single MgO crystal). The accuracy of the direct measurement method is also ~±2% MTD, but the method cannot be applied in every case because sometimes it is difficult to separate the insulator from the sheath and wires. (auth)

6589 (ORNL-tr-2401) STUDY OF MONOCHROMATOR CRYSTALS FOR NEUTRONS HAVING A LATTICE DISTANCE GRADIENT. [PART] I. Rustichelli, F. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Translated for Oak Ridge National Lab., Tenn., from report EUR-4414. 26p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 32912.

6590 (UCRL-19530, pp 340-66) GENERAL INSTRUMENTATION AND DEVELOPMENT. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

Topics include survey of external injection systems for cyclotrons; graphical calculation of waist-to-waist transfer in particle optics; the axial injection system for the 88-inch cyclotron (including design and construction, space-charge effects, and operation of the polarized ion source); acceleration of fission fragments; initial separation-factor measurements on cascade isotope separator; directly heated sample oven for isotope separator ion source; design of a magnetic spectrometer for photoelectron spectroscopy; computer control system for the field-free spectrometer; computer analysis of spectra; some uses of digital polarography; and preparation of isotopic oxygen targets for charged particle activation analysis. (W.H.K.)

6591 (UCRL-50892(Vol.4)(Pt.4)) WEAPONS EFFECTS DISPLAY SYSTEM (WEDS MOD II): MAINTENANCE MANUAL. PART 4. CIRCLE GENERATOR. Berndt, C. W. (California Univ., Livermore. Lawrence Radiation Lab.). Sep 1970. 45p. Dep. NTIS.

The servomechanism used to generate circles for graphic representation of prompt effects on maps or other background pictures projected on the display panel of the WEDS MOD II console is described. The report is intended to be primarily a maintenance manual useful in understanding the function and adjustment of circle generators. (auth)

6592 STRAIGHT CHANNEL MULTIPLIER USED AS A LOW-ENERGY ION SOURCE. Andresen, R. D.; Page, D. E. (European Space Research and Tech. Centre, Noordwijk, Netherlands). Nucl. Instrum. Methods; 88: 99-104(1970).

Experimental results are presented dealing with the energy distribution of positively charged ions occurring within straight channel multipliers. These ions are produced mainly at the positive potential end of the tube by interaction between cascade electrons and residual gas molecules inside the vacuum chamber. There exists a sharp decrease in the energy distribution of the ions corresponding to the applied high voltage of the straight channel multiplier. (auth)

6593 180^0 HOMOGENEOUS FIELD ELECTRO-MAGNETS WITH OPTIMIZED CURRENT TRANSMISSION. Ruedenauer, F. G. (Massachusetts Inst. of Tech., Cambridge). Nucl. Instrum. Methods; 88: 93-7(1970).

Analyzer magnets with high current transmission are needed for high sensitivity mass spectrometers. It is shown that the proper variable to be maximized is the normalized acceptance A_n of the magnet. At given magnet weight A_n can be maximized by proper choice of the relative magnet dimensions. For a 180° deflection magnet optimum design parameters are calculated for a large range in absolute magnet size. Considerable savings in magnet size and power consumption can be achieved by choosing the optimized design. (auth)

6594 ISOTOPE SEPARATOR CONNECTED WITH A 14 MeV NEUTRON GENERATOR FOR ON-LINE FISSION STUDIES. Bocquet, J. P.; Brissot, R.; Crancon, J.; Ristori, C.; Moussa, A. (Centre d'Etudes Nucleaires, Grenoble, France). Nucl. Instrum. Methods; 88: 51-9(1970).

An electromagnetic isotope separator has been connected to a 14 MeV neutron generator in order to study fission-produced rare gases. The experimental set-up is described and the rare gas losses due to decay during transfer are evaluated. (auth)

6595 SOLID STATE NMR SPECTROMETER FOR USE IN A SUPERCONDUCTING MAGNET. Jones, G. Parry; Roberts, R. T. (University Coll. of North Wales, Bangor). J. Phys., E (London); 3: 1003-5(Dec 1970).

A description is given of a compact, low cost spectrometer utilizing radio frequency integrated circuitry. The spectrometer is capable of operation in the range 1 to 30 Mhz at radio frequency levels of 1 to 60 mV. Details are given of a sample head for Zeeman quadrupole measurements in a superconducting solenoid. (auth) (UK)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 6597 and 7449.

6596 (FOA-4-4439) RADIATION INDUCED TRANSIENT EFFECTS IN DIODES. Leman, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Sep 1970. 66p. (In Swedish). Dep. NTIS (U. S. Sales Only).

The theory of transient effects in semiconductor diodes from ionizing radiation is presented. Numerical solutions for the ideal case and the approximative model derived from the division of the diode in bulk regions and depletion regions are discussed. For the bulk region, solutions of the diffusion model with different boundary conditions are suggested and the influence of an electric field is analyzed. Other than plane geometries of the diode are briefly discussed, as well as the problem of determining the lifetime for minority carriers. The transient current decay and amplitude experiments were in good agreement with theory. Probable explanations to the deviations are discussed. (Sweden)

6597 SHORT-CIRCUIT CURRENTS AND OPEN-CIRCUIT EMF'S OF SILICON AND SELENIUM PHOTOCELLS COATED WITH A LAYER OF ^{235}U AND IRRADIATED WITH NEUTRONS. Lebedev, S. Ya.; Taurbaev, T. I. (Physics and Power Inst., Obninsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 4: 487-9 (Sep 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 584-7(Mar 1970).

A study was made of the possible direct conversion of fission-fragment energy into electric power by neutron irradiation of Si and Se photocells coated with ^{235}U. The difference between the short-circuit currents of coated and uncoated photocells was maximum at fluxes of $\sim 10^{11}$ n/cm^2/sec, dropping at higher fluxes due to deterioration of the carrier lifetime. A heating of the Se photocells occurred in the reactor, owing to gamma-ray absorption by the iron substrates. (D.L.C.)

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LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 6402 and 6513.

Basic Processes

Refer also to abstracts 6282, 6283, 6644, 6664, 6700, 6721, 6739, and 6741.

6598 (TID-25563) STUDIES OF DROSOPHILA DISPERSAL AND MIGRATION BY NEUTRON ACTIVATION AND GENETIC TECHNIQUES. Progress Report, 1970. Richardson, R. H. (Texas Univ., Austin). Contract AT(40-1)-4023. 14p. Dep. NTIS.

Research was carried out on improving the efficiency of autoradiographic detection of tag elements, establishing optimum procedures for elimination of background radioactivity, and calibrating the procedure to determine detection limits for the tag elements. Methods for autoradiographic detection of tag elements after neutron activation were refined. Drosophila mimica, D. kambysellisi, and D. imparisetae were labeled with dysprosium, aluminum, manganese, and hafnium. The flies were collected daily for three weeks and collections indicated a territoriality of the three species with little overlap in their microhabitats. (H.L.W.)

6599 CHROMATOGRAPHIC STUDIES OF THE BINDING OF MANGANESE TO SERUM PROTEINS. Pesendorfer, F.; Altmann, H.; Wewalka, F.; Frischauf, H. (Reaktorzentrums, Seibersdorf, Austria). Strahlentherapie, Sonderbaende; 67: 216-22(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Samples of serum containing 0.1 to 0.2 μCi carrierfree ^{54}Mn were chromatographed on Sephadex columns of different grades. Tris-HCl-buffer, pH 7.4 of different molarity was used for elution. In normal cases, 50 to 55% of the added radioactivity was bound to transferrin after 5 min of incubation. This protein-manganese-binding is weaker than the protein-iron-binding. It is improbable that transferrin has a transport function for manganese since the binding of manganese requires greater time than that of iron. Since manganese, added to the serum is not dialysable, an immediate binding to albumin must be assumed. This weak, probably salt-like binding to albumin, is obviously dissociated during the gel-filtration procedure. Interchanges between manganese and Sephadex are responsible for this effect and are influenced by the molarity of the buffer. In a number of sera from pathological cases, a decrease of manganese binding was observed that could not be explained by low ironbinding capacity or low transferrin content of the serum. (auth)

6600 CONTRIBUTION TO THE DETERMINATION OF PARAMETERS OF A BIOLOGICAL MODEL. Delcroix, C.; Cantraine, F. (Univ. Libre, Brussels). Strahlentherapie, Sonderbaende; 67: 234-42(1968). (In French).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

One of the steps when constructing a mathematical model simulating distribution kinetics of a tracer in a biological system is the determination of certain parameters k_i such as, pool size, turnover, and exchange rates between compartments. A new method is suggested replacing the experimental entry data by a theoretical function to facilitate the application of the Laplace transformation. Linear combination of multiexponential functions is performed at the entry of the system $f(t) = \Sigma_i A_i e^{-\lambda_i t}$ the Laplace transformation then gives access to the theoretical form of the systems exit $g_{th} = \Sigma_j B_j(A_1,\lambda_1,k_i)e^{-\gamma_j(A_1,\lambda_1,k_i)t}$. Parameters are obtained by minimizing, using the method of least square fitting between the function $g_{th}(t)$ and the experimental exit data $g_{exp}(ti)$. The method is illustrated by two examples: free plasma cholesterol metabolism by the adrenals and thyroid metabolism. (auth)

6601 STUDY OF IODINE KINETICS IN MAN. Riviere, R.; Comar, D.; Kellershohn, C. (CEA, Orsay, France). Strahlentherapie, Sonderbaende; 67: 251-64(1968). (In French).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

The study is based on two methods of investigation: long-term dietetic balance studies with repeated determinations of the specific activity of plasma, urinary, and fecal iodide carried out with the highest possible accuracy and complementary studies where dynamic thyroid equilibrium was disturbed by antithyroid action on thyroid hormone synthesis. A 4-compartment model has already been presented instead of the classical 3-compartment model where, in addition, an organic thyroid iodide compartment with a rapid turnover was added to the three compartments where the recycling of iodotyrosins takes place and which accounts for the return of inorganic iodide from the thyroid gland. The new model proposed gives a more complete representation of iodide metabolism. With the help of this new theory different states of thyroid function were studied and conventional equations used for the estimation of essential parameters of thyroid metabolism were criticised. (auth)

6602 RESEARCHES ON IODINE POOLS OF MUSCULAR AND ADIPOSE TISSUES. A PRELIMINARY COMMUNICATION. Costa, A.; Cottino, F.; Malvano, R.; Magro, G. (Ospedale Mauriziano, Turin. SORIN, Saluggia, Italy). Strahlentherapie, Sonderbaende; 67: 265-9(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

On equal weight basis, striated muscle contains more iodine than plasma. Muscle iodine is present in both inorganic and organic form, the latter being for the most part precipitable and (in part) extractable with butanol (hormonal iodine). In muscle, the ratio between iodine fractions is different from that in thyroid and in plasma. Iodine is then taken to the peripheral tissues either as iodides ingested in the diet, or by way of release from the thyroid gland, in both hormonal or non-hormonal form. The difference between the amount of a ^{131}I test dose found in the thyroid and excreta, and the total test dose, and the difference between the amount of stable iodine found in the thyroid, excreta and hormonal incretion, and the total iodine ingested by a goitrous patient in the case of chronically increased uptake, is probably represented by contributions to peripheral tissue pools of iodine. These pools possibly allow long-term positive or negative iodine balances to be maintained. Labeling of muscle iodine pools is strikingly slow; the specific activity of the various fractions is distinctly different from that of analogous thyroid and plasma fractions even after weeks of labeling. Preliminary data, obtained in the quantitative and qualitative analysis of muscle iodine pools, are reported. (auth)

6603 KINETICS OF GLUCURONIZATION UNDER NORMAL AND PATHOLOGICAL CONDITIONS STUDIED WITH ^{131}I-LABELED O-IODOBENZOIC ACID. Dohnalek, J.; Eysselt, M.; Huvar, A.; Martinek, K.; Stanicek, J.; Kadlecova, D.; Herufek, B. (Univ. Purkyne, Brno. Onkologisches Institut, Brno). Strahlentherapie, Sonderbaende; 67: 323-9(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Radioiodine labeled ortho-iodo-benzoic acid (OIBS) is conjugated in the liver to orthoiodobenzoylglucuronide (OIBG). In normal cases, 60 to 70% of the OIBS-^{131}I will be conjugated. In patients with chronic hepatitis, liver cirrhosis, carcinoma of the lung, carcinoma of the uterus, and Hodgkins disease the percentage of OIBG-^{131}I increases to 80 to 90% and more. (auth)

6604 NON-EXCHANGEABLE CALCIUM IN URINE. Donath, A.; Pearson, J. D.; Raynaud, C.; Royer, P. (Service Hospitalier Frederic Joliot, Orsay, France. Guy's Hospital, Londres, France. Hopital des Enfants Malades, Paris). Strahlentherapie, Sonderbaende; 67: 486-94(1968). (In French).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

The presence of a non-exchangeable fraction of calcium in urine was first demonstrated in animals and also in man. This calcium, which does not equilibrate with radiocalcium, is separated from Ca_E by the means of a resin after incubation with ^{45}Ca or ^{47}Ca. It is then measured with an atomic absorption spectrophotometer or by activation analysis. The Ca_{NE} was determined in 24 hr urine collections of about 100 people, of whom $^1/_3$ were children. The patients studied were normals and, in addition, patients suffering from various disorders of calcium metabolism. Up to five urine samples of the same person were used to study the reproducibility

of the method. In a certain number of cases, no Ca_{NE} could be demonstrated, but in others a significant fraction was found. In a few hypocalciuric patients it was so important that it represented 25% of the total calcium in the urine of a child suffering from a treated vitamin D refractory rickets; and 70% in an untreated case. These results show that in kinetic studies with radiocalcium the specific activity of urine can be altered by the presence of such a non-exchangeable calcium fraction, which is responsible for the variations in the determination of urine calcium according to the method chosen. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 6665, 6703, 6730, 6732, 6775, 6780, 6781, 6783, 6784, and 6787.

6605 (AEC-tr 7169) METABOLISM OF RADIOISOTOPES IN THE ANIMAL ORGANISM. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 1-158(1966). 220p. Dep. NTIS.

Abstracts were prepared for 13 out of 13 papers dealing with metabolism of radioisotopes in rats. Some radioisotopes included were cerium, niobium, plutonium, ruthenium, and strontium that gave various effects on rats. (P.B.M.)

For abstracts of individual papers see: 6606 through 6618.

6606 (AEC-tr-7169, pp 3-14) BEHAVIOR OF NIOBIUM IN THE ANIMAL ORGANISM. Semenov, D. I.; Balashova, G. N.; Borisova, N. D. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 5-12(1966).

A study was made of the behavior of ^{95}Nb in the rat organism following intravenous, subcutaneous, and peroral administration of doses of 110 to 330 μCi per rat; these doses were chosen in order to determine the distribution in different organs of radioactive niobium doses known to be toxic. Intravenously injected niobium is distributed more or less evenly. The highest concentrations are found in the spleen, bones, kidneys, and liver; they are 1.5 to 2 times lower in the other organs. Subcutaneously administered niobium is absorbed very rapidly, and its distribution in the organs does not differ in any way from that observed following intravenous administration. For the liver and bone marrow the biological half-life is about three weeks, for the spleen and lymph nodes over 64 days, and practically no niobium is excreted from bone tissue (at any rate not for the duration of the experiment). When niobium reaches the blood it is rapidly absorbed by plasma proteins: 92% by albumin and 0.5% by globulin. Following peroral administration, about 0.2 to 0.3% of the niobium is absorbed, the rest is excreted with feces. Intravenously injected niobium enters the intestine mainly through the blood rather than from the liver. (tr-auth)

6607 (AEC-tr-7169, pp 15-32) BEHAVIOR OF UNSEPARATED SOLUTION OF URANIUM FISSION PRODUCTS IN THE ANIMAL ORGANISM. Semenov, D. I. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 13-23(1966).

Following peroral administration to rats of aged unseparated solution of uranium fission products, about 11% of the emitters contained in it is absorbed. Cesium making up 5% of the mixture, is absorbed in its entirety, $^{90}Sr-^{90}Y$, constituting 35% of the mixture, is 25% absorbed, and cerium and ruthenium, constituting 55% and 5% of the mixture respectively, are practically not absorbed. With intravenous administration of this mixture, most is deposited in the bones (30%) and in the liver (21%). In the bones there are mainly strontium–yttrium and cerium, in the liver, cerium, and in the muscles almost exclusively cesium. Excretion of the mixture with urine and feces is rather rapid, since about 75% of incorporated radioactivity leaves the organism by the 120th day. (P.B.M.)

6608 (AEC-tr-7169, pp 33-54) COMPARATIVE DISTRIBUTION OF AGED UNSEPARATED SOLUTION OF URANIUM FISSION PRODUCTS IN DOGS, RABBITS, GUINEA PIGS, AND RATS. Semenov, D. I.; Borisova, N. D. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 25-40 (1966).

Following intraperitoneal administration of aged unseparated solution of uranium fission products to dogs, rabbits, guinea pigs, and rats, incomplete and uneven absorption of its components is observed. While cesium, strontium and, to some extent, apparently yttrium are well absorbed from the abdominal cavity, cerium is only partially absorbed. (P.B.M.)

6609 (AEC-tr-7169, pp 55-66) ADMINISTRATION OF UNSEPARATED SOLUTION OF URANIUM FISSION PRODUCTS TO RATS BY INHALATION. Perov, V. S.; Tregubenko, I. P.; Semenov, D. I.; Kach, A. Z.; Strel'tsova, V. N. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 41-7(1966).

A device is described for dynamic inhalation by small laboratory animals (rats) of radioactive aerosols (^{106}Rh, ^{106}Ru, and $^{90}Sr-^{90}Y$) obtained by mechanical diffusion of appropriate solutions. The main advantages of this device are: possibility of relatively precise assay of inhaled radioactivity and relatively mild contamination of the animal's pelt. Tests involving inhalation by rats of unseparated solution, with a mean particle diameter of about 1 to 4 microns, revealed that the results are reproducible satisfactorily. A preliminary experiment established the behavior in the rat organism of unseparated solution of emitters following inhalation in the form of aerosol. (P.B.M.)

6610 (AEC-tr-7169, pp 67-123) BEHAVIOR IN THE ORGANISM OF CESIUM, STRONTIUM, YTTRIUM, CERIUM, ZIRCONIUM, NIOBIUM, AND RUTHENIUM INHALED BY RATS. Semenov, D. I.; Moskalev, Yu. I.; Buldakov, L. A. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 48-87(1966).

Following inhalation by rats of aerosol traces of cesium, strontium, yttrium, cerium, zirconium, niobium, and ruthenium, 10 to 18% thereof penetrates into the lungs, about 60% is retained in the mouth and nasopharynx, and the remaining 20 to 30% on the skin (mainly on the snout). Intraperitoneal administration of $Na_2 \cdot$ EDTA results in a 50% decrease in yttrium and cerium content in the organs, after inhalation administration, causing an increase in excretion thereof with urine. The use of this complexon is promising in the event emitters penetrate into the organism by inhalation. (P.B.M.)

6611 (AEC-tr-7169, pp 124-36) INHALATION OF PLUTONIUM BY RATS. Tregubenko, I. P. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 89-97(1966).

Plutonium aerosol, inhaled by rats in the form of PU $Pu(NO_3)_4$, is 25% retained in the respiratory tract. From the toxicological point of view inhalation is the most dangerous means of access into the organism, because of the relatively high degree of reabsorption from the lungs and predominant deposition of the reabsorbed share in the skeleton. (P.B.M.)

6612 (AEC-tr-7169, pp 137-52) THE EFFECT OF VARIOUS DIETS ON THE BEHAVIOR OF ^{91}Y AND UNSEPARATED SOLUTION OF URANIUM FISSION PRODUCTS. Borisova, N. D. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 99-109(1966).

Maintenance of rats on various diets before and after administration of yttrium affects its behavior in the rat organism to the same extent and in the same direction. The fatty, carbohydrate, and protein-free diets diminish and the high protein diet increases reabsorption of yttrium from the gastrointestinal tract. A maximum effect with respect to eliminating yttrium from the organism is obtained by administration of $Na_2 \cdot$ EDTA in the case of a rachitogenic diet, however, with other diets $Na_4 \cdot$ EDTA yielded a somewhat greater effect than with an ordinary diet. Administration of trimetaphosphate (TMP) and folliculin had almost no effect on the behavior of yttrium with all diets tested. (P.B.M.)

6613 (AEC-tr-7169, pp 153-70) THE EFFECT OF SEX, AGE, CASTRATION, SEX HORMONES AND ADRENALECTOMY ON THE BEHAVIOR OF ^{137}Cs AND ^{144}Ce IN THE RAT ORGANISM. Kulikova, V. G. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 111-23(1966).

Such biological factors as sex, age, castration, adrenalectomy, and sex hormones affect the fate of cesium, which is similar in its chemical properties to so-called physiological potassium, and cerium, an element that is not considered physiological. This indicates that the behavior of even unphysiological elements in the organism is subject to physiological laws and is largely determined by them. The data obtained indicate once more the complex correlations and interactions existing in the organism between various hormonal systems and organs. A marked decrease was established in the rat skeleton under the effect of multiple injections of large doses of folliculin. The following conclusions were reached concerning the various parameters studied: In the early period following administration, deposition of cerium in the muscles, liver, and skeleton is greater in females than in males. Castration eliminates the sex-related differences in distribution of cesium, lowering its level in the female skeleton to the level found in uncastrated males. The effect of folliculin on cesium distribution is related to sex and castration. Multiple injections of progesterone retard excretion of cesium from the muscles and skeleton of castrated males, as compared to uncastrated animals. Adrenalectomy increases the cerium level in the muscles, lungs, skeleton, and liver of females. (P.B.M.)

6614 (AEC-tr-7169, pp 171-9) FATE OF PLUTONIUM IN THE PREGNANT ORGANISM, AND ITS EFFECT ON VIABILITY OF THE FETUS. Tregubenko, I. P. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 125-30 (1966).

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The behavior of plutonium incorporated during pregnancy in rats is very different from its behavior in the nonpregnant organism, and it is related to the stage of pregnancy: deposition of plutonium in the skeleton of pregnant animals is very low, while deposition in the liver in early pregnancy increases, and in late pregnancy decreases, as compared to nonpregnant rats. Transfer of plutonium injected into the maternal organism during pregnancy to the fetus increases as the pregnancy advances, reaching 42% of the dose administered to the mother in late pregnancy. Pregnancy occurring after plutonium has been incorporated in tissues does not alter its fate in the organism. (P.B.M.)

6615 (AEC-tr-7169, pp 180-98) THE EFFECT OF ETHYLENEDIAMINETETRAACETATE ON BEHAVIOR OF STRONTIUM AND RARE-EARTH ELEMENTS IN THE ORGANISM. Tregubenko, I. P.; Kach, A. Z.; Pani, G. E. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 131-42(1966).

A study was made of the effect of a complexon, ethylenediaminetetraacetate (EDTA), on the behavior of strontium and rare earths in the rat organism. The pharmacological action of EDTA consists of reducing the calcium concentration in blood, which, with toxic doses, elicits calcium induced tetanus, shock, and cardiac arrest. EDTA visibly increases excretion of rare earths with urine, lowering their concentration in soft tissues (by 4 to 10 times in the liver). EDTA has no effect on excretion of strontium from the organism. EDTA affects excretion of rare earths both following single and multiple administration. A correlation was established between effectiveness of EDTA and the dose and time of administration, as well as the means of administration (intravenous, intraperitoneal, or oral). (P.B.M.)

6616 (AEC-tr-7169, pp 199-204) EXPERIMENTS ON THE EFFECT OF SOME SUBSTANCES ON THE BEHAVIOR OF PLUTONIUM IN THE ORGANISM. Tregubenko, I. P. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 143-6 (1966).

A study was made of different types of colloids and of a number of complex-forming substances with respect to their effect on the behavior of plutonium in rats. It was established that negatively charged colloids of zirconium and yttrium have a pronounced effect on deposition of the emitter in the skeleton and soft tissues. Finely dispersed colloid zirconium elicits a significant increase in excretion of plutonium with urine; the larger particled zirconium citrate and particularly yttrium causes a marked increase in deposition of the emitter in the liver as well as in the spleen. Complex-forming substances whose stability constants for the complexes produced are not too high have practically no effect on the behavior of plutonium. (P.B.M.)

6617 (AEC-tr-7169, pp 205-9) COMBINED EFFECT OF COMPLEXING SUBSTANCES AND DIURETICS ON THE BEHAVIOR OF EMITTERS IN THE ORGANISM. Tregubenko, I. P.; Semenov, D. I. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 205-9(1966).

A study was made of the effect of complexing agents (EDTA, HMP) combined with diuretics (diuretin, methylcaffeine, mercuzal) as well as with epinephrine on the behavior of yttrium, cerium, and plutonium in rats. Differences were established between the action of EDTA and HMP. Administration of both together had a lesser effect than EDTA alone. Diuretics did not affect the behavior in the organism of yttrium, cerium, and plutonium or excretion thereof. When combined with EDTA methylcaffeine inhibited increase in deposition of cerium in the bones, which is typical for EDTA alone. Mercuzal combined with HMP somewhat increased plutonium deposition in the liver. Epinephrine alone or in combinations with EDTA and HMP mildly increased deposition of yttrium in the liver. (P.B.M.)

6618 (AEC-tr-7169, pp 210-20) DECREASED REABSORPTION OF EMITTERS FROM THE GASTROINTESTINAL TRACT AND USE OF COMPLEXONS FOR REMOVAL OF REABSORBED FRACTIONS THEREOF FROM THE ORGANISM. Semenov, D. I. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial; No. 46, 151-8(1966).

Parenteral administration of complexons increases absorption of emitters from the gastrointestinal tract of rats. Barium sulfate and Espatite-1 equally diminish absorption of strontium from the gastrointestinal tract (by 2 to 2.5 times). Torfite was found to be less effective. The hydrogen form of Espatite-1 diminishes absorption of cesium from the gastrointestinal tract. Torfite is ineffective. Administration of lead sulfate prolongs significantly survival time and increases the mean survival of the rats who were given toxic doses of unseparated solution of emitters with water. Under the same conditions, barium sulfate, Espatite, and calcium fluoride were ineffective; sodium silicate elicited negative results. (P.B.M.)

6619 (AEC-tr-7178) EXPERIMENTAL STUDY OF CONTAMINATIONS BY ^{242}Cm AND THEIR TREATMENT. Nenot, J. C.; Morin, M.; Lafuma, J. Translated for Savannah River Lab., Du Pont de Nemours (E. I.) and Co., Aiken, S. C., from Health Phys.; 18: 613-22(Jun 1970). 17p. Dep. CFSTI.

Curium-242 is relatively little known from the biological point of view. This study enabled us to establish a parallel between its chemical and biological properties and to compare it with elements of the same family, such as ^{239}Pu or other families, such as the rare earths. A metabolic study of a ^{242}Cm solution injected locally into rats showed that degradation was rapid and that the distribution of the metabolized portions always remained the same. The experiments were highly reproducible. DTPA therapy of intramuscular contaminations demonstrated the stability of the ^{242}Cm-DTPA complex and specified the importance of the chelating agent as a protector of the skeleton, its effectiveness being directly dependent on early therapy. This study made it possible to determine a therapeutic procedure applicable to human contaminations. (tr-auth)

6620 (BNWL-B-2) HYBRID COMPUTER SIMULATION OF THE BIOLOGICAL DISPOSITION OF INHALED PLUTONIUM OXIDE. Dionne, P. J.; Stuart, B. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1970. Contract AT(45-1)-1830. 58p. Dep. NTIS.

The retention and translocation of inhaled $^{239}PuO_2$ are described by a mathematical model. The model consists of first order ordinary differential equations and was simulated on BNW's hybrid computer. The parameter values listed in the block diagrams of the model were obtained by matching the simulation to data gathered from several long term studies on beagle dogs. (auth)

6621 (BNWL-SA-3307) U. S. TRANSURANIUM REGISTRY. Newton, C. E. Jr.; Norwood, W. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 18 May 1970. 9p. (CONF-700514-2). Dep. NTIS.

From American Industrial Hygiene Association Conference, Detroit, Mich.

The operation of the Registry, a unique program established to provide for the centralization, accumulation, evaluation and dissemination of data on the uptake, distribution, and retention of the transuranic elements and their effects upon exposed employees is described. The useful purposes of the Registry are to establish: the correlation between health physics estimates of depositions and the assay of the organ depositions; pathological changes, if any, occurring in tissues as related to the activity of the deposited material; the degree of correlation that exists between animal reactions and patterns and those established by mankind; and finally, to serve as an information exchange center on this subject as a national, or even an international, service. (auth)

6622 (UCD-472-117, pp 41-5) WHOLE-BODY ^{90}Sr RETENTION AND DISTRIBUTION IN TRABECULAR AND CORTICAL BONE OF BEAGLES. RELATION TO TEMPORAL PATTERNS OF PLASMA AND EXCRETA CONCENTRATIONS. Della Rosa, R. J.; Goldman, Marvin (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Time-course studies of the ^{90}Sr activity in plasma and urine indicate biological half-periods similar to those for ^{90}Sr loss in trabecular bone. Cortical bone may provide the ^{90}Sr label for trabecular bone which, in turn, is in equilibrium with plasma and which determines the final concentration in the excreta. Plasma ^{90}Sr concentration thus affords an estimate of the radiostrontium in the exchangeable pool of the skeletal depot. (auth)

6623 (UCD-472-117, pp 46-8) ^{90}Sr CONCENTRATIONS IN SOFT TISSUES OF BEAGLES. Della Rosa, R. J.; Goldman, Marvin; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

At body burdens up to 400 μCi, 1 yr after the end of ^{90}Sr feeding, plasma and soft tissue concentrations were approximately 40 pCi ^{90}Sr/g. Doses to soft tissues, including gonads, were about 2 mRads/day in dogs at extremely high risk for bone and bone marrow tumors. The data suggest minimal risk from ^{90}Sr β doses to tissues that are not in or near bone. (auth)

6624 QUANTITATIVE UPTAKE MEASUREMENTS OF ^{99m}Tc IN SALIVARY GLANDS AND STOMACH AND CONCENTRATION OF ^{99m}Tc, ^{132}I, AND ^{82}Br IN GASTRIC JUICE AND SALIVA. Harden, R. McG.; Alexander, W. D.; Shimmins, J.; Russell, R. I. (Gardiner Inst., Glasgow). Strahlentherapie, Sonderbaende; 67: 77-87(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

In man iodide is concentrated in the thyroid, in the salivary glands, and in the stomach. In the salivary glands and stomach the iodide concentrated is not bound and thus the iodide trap can be studied in isolation. Two techniques have been used: quantitative uptake measurements over the stomach and salivary glands using isotope scanning and dot counting techniques and measurements of the saliva/plasma (S/P) and gastric juice/plasma (GJ/P) ratios and clearances. I, Tc, and Br are members of the VIIth group of the periodic table. The peroxy anion pertechnetate has biologically many similar properties to iodine. A scanning technique was used to obtain information regarding salivary and gastric physiology not otherwise easily obtainable and has demonstrated fallacies in previous studies where uptake was measured using a scintillation counter. We have also measured simultaneously the concentration of ^{132}I, ^{99m}Tc, and ^{82}Br in parotid saliva and gastric juice. The counts for the individual isotopes were obtained by solving simultaneous equations with a computer. The concentration of the ions was in the order $I^- > TcO_4^- > Br^-$. The GJ/P I^- and GJ/P TcO_4^- ratios were less than the corresponding ratios in saliva. In contrast Br was found to be more concentrated in gastric juice than in saliva. In a further group of patients the I^-/TcO_4^- clearance ratio was found to remain constant with increasing flow rates whereas the ratio in gastric juice fell. Evidence is presented that in the stomach, although TcO_4^- and Br^- may share with I^- one transport mechanism, they are also transported by a mechanism not common to I^-. (auth)

6625 DETERMINATION OF $^{14}CO_2$ IN EXPIRED AIR AFTER INGESTION OF TRIOLEIN: ABSORPTION STUDIES USING FATS. METHOD COMPARISON. Grenier, J. F.; Kachelhoffer, J.; Sava, G.; Barth, A. M.; Weiss, A. G. (Groupe de Recherches de Pathologie Digestive Chirugicale, Strasbourg). Strahlentherapie, Sonderbaende; 67: 100-8(1968). (In French).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Radioiodinated fats will not give reliable results when used in fat absorption studies and use of ^{14}C labeled triolein and oleic acid is suggested. Recently, a method for intestinal fat absorption studies by measuring the radioactivity of the CO_2 in expired air after ingestion of ^{14}C-labeled fats was reported. Comparative studies were carried out measuring the radioactivity of plasma, feces and expired air (FT 50, Friesecke & Hoepfner) after the ingestion of ^{14}C labeled fats. Radioactivity in the blood increased very rapidly but it could only be detected in the exhaled air ½ to 2½ hours after ingestion of the tracer. Furthermore, the peak radioactivity in the plasma appeared between the 3rd and the 4th hour after ingestion while maximal radioactivity in the CO_2 was measured only after the 5th and 7th hour. Finally, radioactivity in CO_2 was generally higher when lower plasma levels of radioactivity were obtained. These radioactivity patterns are in agreement with the fact that plasma curves of radioactivity will mainly be influenced by absorption and fixation of fats while the radioactivity in the exhaled air is a reflection of metabolic behavior of fats after their absorption. Therefore, the two methods are complementary. It should be stressed again that reliable results on fat absorption may only be obtained using ^{14}C labeled fats and measurements of fecal radioactivity. (auth)

6626 ABSORPTION AND DISTRIBUTION OF ^{114m}In IN RABBITS. Malamos, B.; Kostamis, P.; Constantinides, C.; Binopoulos, D.; Sfontouris, J. (Univ., Athens). Strahlentherapie, Sonderbaende; 67: 157-63(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Indium-113m is used for liver, lung, and blood pool scanning. Its only significant emission of a 390 keV γ photon and its 1.7 hour half-life minimize patient exposure. Since indium compounds are extremely toxic, absorption rates and distribution of ^{114}In in critical organs, as well as the whole metabolic pathways which this radioisotope follows in the organism, were studied in rabbits. After the administration of a tracer dose of ^{114m}In, the absorption and excretion rates were determined by using a clinical whole-body counter. The results indicate that a difference exists between the whole-body radioactivity and that obtained by summing up the activities of critical organs. This difference is probably caused by the deposition of indium in bone and muscle. (auth)

6627 DETERMINATION OF CALCIUM ABSORPTION WITH RADIOISOTOPES. Sack, H. (Ruhr Univ., Bochum, Ger.). Strahlentherapie, Sonderbaende; 67: 174-7(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

350 intestinal Ca-absorption tests were carried out within the last 3 years. Three methods were used: 2h serum activity measurement which is unreliable, a double isotope method of our own, including determination of ^{85}Se poolsize, which gives more reliable results and may be expressed in percent absorption, and the most exact but complicated method of comparing specific serum and urine radioactivity after oral and i.v. application of ^{45}Ca and ^{47}Ca. The extent of Ca-absorption depends on age and amount of carrier in the tracer dose. Mean values with carrier of 200 mg $CaCl_2$ were 40 ± 5% of dose, with 500 mg carrier 25 ± 14.5%. Values ranged from 16–58% in normals. Little difference in absorption was found between different salts of calcium (phosphate, citrate, carbonate, chloride). Influence of Vitamin B_6, Vitamin C, and Vitamin D_2 on calcium absorption was investigated. (auth)

6628 FATE OF THYROXINE ^{131}I IN THE TISSUES: AN IN VIVO APPROACH. Demeester-Mirkine, N.; Demeester, M.; Ermans, A. M. (Univ. Libre, Brussels). Strahlentherapie, Sonderbaende; 67: 243-50(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

The fate of ^{131}I-T4 in tissues is not well-known at present. An attempt was made to assess the process by studying the distribution of a tracer dose of ^{131}I labeled thyroxine simultaneously in plasma and tissues, by means of blood samples and in vivo radiation measurements of the thigh. After estimating, the blood radioactivity, seen by the detector in vivo, it is possible to follow the evolution of the extravascular thyroxine. From the mathematical analysis of this curve by a method of computer-programmed numerical deconvolution, it is possible to deduct the curve for the tissues; this curve represents the evolution of the thyroxine level in the tissues as it might be observed if the tissues were subjected to a single slug injection of thyroxine. (auth)

6629 EXAMINATION OF THE DISTRIBUTION PATTERN OF LABELED DRUGS. Schmidt, H. A. E. (Evgl. Krankenhaus Bethesda, Duisberg, Ger.). Strahlentherapie, Sonderbaende; 67: 353-64(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

The use of labeled drugs allows study of the distribution pattern of substances even in minimal amounts, below chemical detectability. An example is given how a radioactive labeled drug may be studied in animal experiments prior to clinical use. Whole-body autoradiography leads first to an estimate where and when highest blood or organ concentration of the substance may be expected. Analysis of the blood level gives information on blood concentration, elimination rate, protein binding, pool sizes and eventual metabolic breakdown. If metabolic breakdown occurs, chromatographic methods may be included in the study. Assay of urine and fecal activity following oral and intravenous application allows calculation of the extent of absorption. Tissue concentration at the time of maximal concentration and organ retention after the non-absorbed part of the substance is excreted may be determined. Finally, microautoradiographic studies give information on the distribution of the preparation within the individual organ. (auth)

6630 HUMAN TOTAL-BODY RETENTION AND EXCRETORY ROUTES OF ^{75}Se FROM SELENOMETHIONINE. Lathrop, K.; Harper, P. V.; Malkinson, F. D. (Univ. of Chicago. Argonne Cancer Research Hospital, Chicago). Strahlentherapie, Sonderbaende; 67: 436-43(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Information about the excretory pathways and retention pattern of ^{75}Se after a single dose of ^{75}Se-methionine is important for accurate assessment of the absorbed radiation dose from diagnostic procedures employing this agent, and for interpretation of the metabolic pathways taken by this element that is ingested in microgram quantities daily by people throughout the world. Total-body counting data from several subjects indicate that 50% of the dose is eliminated by 80 days and that retention is characterized by a three-component curve with $t_{½}(1)$ 6.8 d (8%); $t_{½}(2)$ = 73 d (64%); and $t_{½}(3)$ = 325 d (28%). A total of less than 5% of the injected radioactivity is eliminated through the breath, hair, nails, and skin. Urinary excretion seems to account for 80% of the dose and fecal excretion for the remainder, complete elimination being achieved about 3 yr after administration. In spite of this long retention time the total-body absorbed radiation dose is modest because of the type of physical decay exhibited by ^{75}Se, being approximately 7.5 rad/mCi for the γ component, and 1.7 rad/mCi for the β-like radiation. (auth)

XUM

6631 FIRST RESULTS FROM A STUDY OF PLASMA AND ERYTHROCYTE CLEARANCE USING BMHP. Desgrez, A.; Combrisson, A.; Griveau, P. (Hospitalier Frederic Joliot, Orsay, France. Hopital Saint-Antoine, Paris). Strahlentherapie, Sonderbaende; 67: 472-9(1968). (In French).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

BMHP and MHP^{197}Hg were administered for scintigraphy of the spleen. Thereafter, a number of hematological tests and blood clearance of the tracer were determined. Clearance was measured for plasma and erythrocytes separately over a 24-hr period. Some patients were examined before and after splenectomy. Results suggest that, in some cases, alteration is not homogenous throughout red cell population but develops progressively: a model for this mechanism is suggested. (auth)

6632 SPATIAL RECORDING OF DISAPPEARANCE CONSTANTS OF ^{133}Xe WASHOUT FROM THE LUNG. MacIntyre, William J.; Inkley, Scott R.; Roth, Elaine; Drescher, William P.; Ishii, Yasushi (Case Western Reserve Univ., Cleveland. Univ. Hospitals, Cleveland). J. Lab. Clin. Med.; 76: 701-12(Oct 1970).

Previous measurements of the washout of ^{133}Xe from the lung were confined largely to the determination of the clearance constant from the entire lung or from a number of specific sites. The present investigation demonstrates that a sufficient number of Xe washout curves can be simultaneously recorded so that a complete functional visualization of the lung can be described with a display of the disappearance constant at each site similar to a conventional scan of the distribution of radioactivity deposited in that organ. This object was accomplished by calculating washout curves for each element of a scintillation camera field following perfusion of the lungs with dissolved ^{133}Xe injected intravenously. Serial scans of the ^{133}Xe distribution were obtained at time intervals sufficiently short so that the clearance rate could be established and the initial distribution determined. The Xe disappearance rates at each camera element were obtained by least-squares fitting of the logarithm of the counts collected at each element during the interval of each frame. In order to integrate visually the variation of clearance at each site, both numerical matrices and three dimensional models of initial distribution and disappearance constants were utilized. While the spatial resolution of a functional scan cannot be expected to equal the resolution of a distribution scan, it is believed that the ability to present integrated information on a functional parameter of regional lung ventilation will provide a valuable tool for the diagnosis and evaluation of various abnormalities of this organ. (auth)

Radiation Effects

Refer also to abstracts 6461, 6668, 6674, 6689, 6712, 6822, and 6825.

6633 (CONF-691106–, pp 46-72) CURRENT RESEARCH ON RADIATION DAMAGE PROCESSES BY LOW ENERGY HEAVY PARTICLES. Watt, D. E.; Hughes, S. (Dundee Univ. (Scotland). Dept. of Medical Biophysics).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

When intermediate energy neutrons interact with tissue, a significant proportion of the energy is dissipated by non-ionizing, nuclear collisions of the heavy secondary particles, C, N and O. Calculations are presented of the electronic and nuclear stopping powers and ranges for H, C, N and O in tissue-like media over the energy interval where nuclear collisions predominate and specific fragmentation curves derived. These results permit deduction of the general structure of the knock-on cascades. Differences in the physical processes of molecular damage caused by ionizing and nuclear processes are discussed. An experimental program is described that is designed to determine: extrapolated ionization ranges and cross-sections for H, C, N and O in hydrocarbon gases over the energy region below the Bragg-ionization maximum, where nuclear processes become important; the inactivation cross-sections for protons undergoing screened nuclear collisions on biological macromolecules; the type, kinetic energy, and production cross-sections of the fragments; and the differential screened nuclear and inelastic cross-sections for ions, having energies below 5 KeV, on hydrocarbon gas molecules. This data is intended to provide basic information on the spatial distribution and mechanisms of the various low-energy absorption processes and on the precursors to chemical action which may result in biological damage. Topics discussed include the influence of molecular binding and the state of the medium on the interpretation of results from the gaseous phase, radiation damage theory, and the production of free oxygen along the particle tracks. (auth)

6634 (CONF-691106–, pp 153-72) SOME GENERAL ASPECTS OF RELATIVE BIOLOGICAL EFFECTIVENESS OF RADIATION OF DIFFERENT QUALITIES FOR EFFECTS ON CELLS. Neary, G. J. (Medical Research Council, Harwell (England). Radiobiological Research Unit).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Experimental data on RBE in cellular radiobiology are reviewed and show that only limited degrees of regularity in restricted areas exist at present; no general unifying principle emerges. The reason lies in the incompleteness of present knowledge and understanding of the basic mechanisms of radiation action and cellular response to radiation-induced damage. There are three stages of evolution of radiation damage: various primary molecular lesions; lesions remaining after completion of fast physicochemical reactions; residual lesions after the intervention of post-irradiation cellular repair and by-pass mechanisms. The three classes of lesions probably depend in different ways on the quality of the radiation and the presence of modifying agents. Some new data on DNA strand breakage in vitro in Escherichia coli illustrate the distinction between stages 2 and 3 of lesion production, while data on the comparison of the effects of x rays of low quantum energy with those of heavy particles illustrate how physical and cell biological factors are both involved in the consideration of radiation quality. It is concluded that for a better synthesis and understanding of RBE phenomena much more basic data is required, including better knowledge of the radiation chemistry of radiation effects on cellular macromolecules and structures. The possibility of synergistic interaction between radiations of different quality must be examined for radiations such as fast neutrons that produce a broad spectrum of radiation qualities. A better appreciation of the fundamental mechanisms of radiation action and the influence of radiation quality thereupon is needed for a more reliable evaluation of the practical problems arising in the fields of radiation protection and radiotherapy. (auth)

6635 (CONF-691106–, pp 462-79) COMPARATIVE EARLY AND LATE EFFECTS OF FAST NEUTRONS AND X RAYS ON RAPIDLY LABELED RNA SYNTHESIS IN REGENERATING MOUSE LIVER. Wiley, Albert L. Jr.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco, Calif.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Effects of high LET radiation on RNA synthesis were investigated. Rapidly labeled RNA was of special interest because of its known content of messenger RNA. Using the partially synchronous, regenerating liver system, several types of experiments were done to compare the effects of x rays (250 KVP) and fast neutrons (fission and 2.6 MeV cyclotron), with special attention to early and late effects and to the cell cycle dependence of these effects. Young adult LAF_1 mice were exposed to x ray or neutron radiation (immediately followed by a 35-minute pulse of ^{3}H-uridine), delivered 5.5, 32, or 48 hours after partial hepatectomy. No significant depression of the incorporation of ^{3}H-uridine into RNA after x radiation (dose, range, 0 to 950 R) was detected during any of these times. Similar experiments with neutrons (0 to 520 rads) produced an approximately 48% depression at 32 hrs after hepatectomy (i.e., early "S" in the cell cycle of this system). Late effects were investigated by irradiating mice with either x rays (300 R) or fission neutrons (300 rads) and subjecting them to hepatectomy 9 months later. No significant depression in the synthesis rate of rapidly labeled RNA occurred at 5.5, 32, or 48 hours after hepatectomy in the x irradiated group. However, prior neutron irradiation caused a 75% depression at 5.5 hours after hepatectomy. On the basis of these observations the regenerating mouse liver appeared to be insensitive to x radiation in the dose range studied; but, in contrast, both early and late, cell cycle related effects were observed after relatively low doses of fast neutron radiation. (auth)

6636 (ORNL–4610) ECOLOGICAL ASPECTS OF RESPONSES OF LIRIODENDRON TULIPIFERA L. AND ACER SACCHARINUM L. TO FAST NEUTRON RADIATION AND REDUCED LIGHT. Harris, W. F.; Witherspoon, J. P.; Olson, J. S. (Oak Ridge National Lab., Tenn.). Nov 1970. Contract W-7405-eng-26. 202p. Dep. NTIS.

Thesis. Submitted by W. F. Harris to Univ. of Tennessee, Knoxville.

Seedlings of yellow poplar (Liriodendron tulipifera) and silver maple (Acer saccharinum) were irradiated as dormancy was breaking with doses of fast neutron radiation ranging to 500 rads. Plants were grown in 100, 50, and 25% of full sunlight for the

duration of a two-year study. Plants were watered daily and fertilized in the spring of each year. Morphological variables that were measured included: leaf emergence terminal and lateral bud mortality, development of leaf aberrations, leaf histology, terminal and lateral shoot growth in length, and leaf area development. Results of examination of morphological responses indicated that production of aberrant foliage represented a poor criterion for assessment of damage to a landscape following exposure to ionizing radiation since there was neither a dose-effect relationship nor an interspecific interphase chromosome volume relationship. Terminal and lateral bud mortality were the only responses independent of reduced light. Physiological responses that were examined included: net photosynthesis, biomass production, carbohydrate accumulation, and water relations. Physiological responses that were observed were not independent of structural modifications, but did reflect species differences in radiosensitivity. Transpiration rates were altered, primarily as a result of altered morphology. The results suggested that the increased drought-susceptibility of radiation-damaged plants is the result of increased demand for water and decreased capacity to supply water. Reduced light treatments increased the potential drought-susceptibility of radiation-damaged plants. The relative ability to tolerate shade exhibited by yellow poplar and silver maple was apparent. Tolerance, as a species characteristic (or assemblage of characteristics), was sensitive to alterations following radiation damage, particularly in the relatively more radiosensitive yellow poplar. The results of this study provided a basis to explain the discrepancies between predicted and observed radiosensitivities found in studies of landscape irradiation. (C.H.)

6637 (RLO-2221-T-2-1) EFFECT OF IONIZING RADIATION ON GIBBERELLIC ACID. Sideris, E. G.; Nawar, M. M.; Nilan, R. A. (Washington State Univ., Pullman. Dept. of Agronomy). [1969]. Contract AT(45-1)-2221. 19p. Dep. NTIS.

Aqueous solutions of 10^{-6} M gibberellic acid, irradiated with relatively low doses of γ rays failed to induce α-amylase activity in barley embryo caryopses. The relationship between irradiation dose and gibberellic acid inactivation is an exponential one. Presence of the hydroxyl free radical scavengers, potassium iodide and p-aminobenzoic acid, protects the biological activity of gibberellic acid as it is measured by the α-amylase bioassay. The results suggest that gibberellic acid in aqueous solutions is inactivated by γ rays by an indirect action probably through reactions with free radicals from the radiolysis of water. Irradiation of young barley (Hordeum vulgare) seedlings did not affect their gibberellic acid content, but in seedlings from irradiated caryopses the gibberellic acid concentration was reduced. (auth)

6638 (UCD-472-117, pp 55-6) LUMINESCENCE IN NORMAL AND NEOPLASTIC TISSUE. Goldman, Marvin; Stone, J. M. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

X irradiation of normal or neoplastic tissue ash induces radio- and thermoluminescence, the light output of which is characteristic of the tissue of origin. Mammary neoplasms exhibited 4 to 8 times the luminescence of normal tissue, possibly due to the presence of NaCl crystals. (auth)

6639 (YALE-2653-42) THREE YEAR PROGRESS REPORT, AUGUST 1, 1967-JULY 31, 1970. Hutchinson, Franklin (Yale Univ., New Haven, Conn. Dept. of Molecular Biophysics and Biochemistry). Contract AT(30-1)-2653. 8p. Dep. CFSTI.

Research was conducted on characterization of the lesion produced by ultraviolet light in DNA containing the base analog bromouracil. The major lesion is a single-strand break which occurs only in that strand of the DNA duplex containing bromouracil. Studies were conducted on the relationship between the effects of single-strand breaks and of double-strand breaks in the DNA double helix, and the probability of integration of the DNA in the process of bacterial transformation in Diplococcus pneumoniae. A detailed characterization of the effect of double-strand breaks in DNA produced by ionizing radiation was made and the relationship of these breaks to cell survival was studied. The question as to whether the DNA molecule extracted from bacteria is in fact an entire cell genome was investigated. Nuclease activity associated with competent Bacillus subtilis cells was investigated; the nuclease activity is unusual in that it breaks both strands of the double helix simultaneously. (H.L.W.)

6640 BIOLOGICAL EFFECTS OF MAGNETIC FIELDS. VOLUME 2. Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corporation (1969). 324p. $17.50.

Separate abstracts were prepared for 17 chapters of the book. An introductory chapter discusses magnets in biological research, and a subject index is included. (H.L.W.)

For abstracts of individual chapters see: 6641–6646, 6676, 6764, 6765, 6790–6796, and 6812.

6641 EFFECTS OF NEAR-ZERO MAGNETIC FIELDS UPON BIOLOGICAL SYSTEMS. Conley, Charles C. (Ames Research Center, Moffett Field, Calif.). pp 29-51 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

The significance of effects on man of exposure to nearly null magnetic fields of outer space is pointed out. Techniques for producing low and very low magnetic fields are listed and described. A tabular summary of reports from the literature on low and near-zero magnetic field studies is presented. Data on effects of magnetic field intensity and exposure duration on various plants, animals, and microorganisms are tabulated. Experiments were conducted on mice subjected to very low magnetic fields; total acid phosphatase activity of peritoneal macrophages was measured following injection of a lipopolysaccharide. It was found that there was a lower activity in cell suspensions from animals kept at low field intensities as compared with controls. In vitro investigations on nulled-field effects on acid and alkaline phosphatase and transaminase resulted in a lack of significant effect. It is suggested that any biological influence that magnetic fields exert may be detectable only in cases of fairly prolonged exposure of complex sequences of cellular or biochemical events rather than in systems involving the instantaneous application of a direct magnetic force upon a single specific chemical reaction. (H.L.W.)

6642 EFFECTS OF A MAGNETIC FIELD ON DNA SYNTHESIS BY ASCITES SARCOMA 37 CELLS. D'Souza, Leo; Reno, Vernon R.; Nutini, Leo G.; Cook, Elton S. (Institutum Divi Thomae, Cincinnati). pp 53-9 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

Suspensions of ascites sarcoma cells from mice were exposed to a magnetic field of 7300 Oe for 1 to 3 hr. Tritiated thymidine was added to some cell suspensions during exposure to the magnet, and it was added after removal of other samples from the magnet. DNA synthesis was decreased 18 to 24% in all samples regardless of procedure. Longer exposures had no effects on diminishing DNA synthesis. Respiration was also depressed by magnetic fields. (H.L.W.)

6643 EFFECTS OF MAGNETIC FIELDS ON CELLULAR RESPIRATION. Cook, Elton S.; Fardon, John C.; Nutini, Leo G. (Institutum Divi Thomae, Cincinnati). pp 67-78 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

Previous studies on exposure of tissue samples to 7300 Oe magnetic fields showed that respiration of ascites sarcoma, ascites Ehrlich adenocarcinoma, and embryonic mouse kidney was depressed, while respiration of yeast cells and that of adult mouse kidney was not affected. A new constant pressure microrespirometer for experiments on very small amounts of tissue is described and results of experiments using this apparatus are presented. Exposures of 80 Oe decreased respiration of ascites sarcoma cells, embryonic kidney and liver tissues of mice, and neonatal liver of mice. No effect was observed on adult kidney and liver tissues of mice. Higher field strengths up to 10,000 Oe produced no significantly greater effect. Yeast (Saccharomyces cerevisiae) respiration was stimulated by field strengths of 85 Oe or higher. (H.L.W.)

6644 MAGNETIC FIELD AND IN SITU ACETYLCHOLINESTERASE IN THE VAGAL HEART SYSTEM. Young, Wei (Univ. of California, Livermore). pp 79-102 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

The vagal heart preparation in the frog is described. This biological system made it possible to study acetylcholinesterase activity in situ in relation to various physical factors on a native enzyme. The activity of the enzyme can be traced by introducing substrate either by injection of microquantities of acetylcholine or by vagal stimulation to perturb the biological equilibrium. It was found that a magnetic field invariably increased AChE activity at low field strength. The increased activity can be reversed by application of AChE inhibitors or some small organic molecules such as dimethylsulfone oxide and taurine. A nonuniform magnetic field consistently increases the rate of hydrolysis of acetylcholine introduced either chemically into the isolated frog vagal heart preparation or by vagal stimulation in the early phase of the applied field. Prolonged exposure of the field produces arrhythmia. The magnetic effects seem to be reversible, especially in the low field. Magnetokinetics are discussed in conjunction with bridge formation and conformational changes of the enzyme molecule. (auth)

6645 CHANGES IN SODIUM AND POTASSIUM CONTENT OF URINE FROM MICE SUBJECTED TO INTENSE MAGNETIC

XUM

FIELDS. Hanneman, G. D. (Civil Aeromedical Inst., Oklahoma City). pp 127-35 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

Mice approximately 22 weeks old and weighing 24.3 g were exposed to a magnetic field of 14 kOe for 24 hr. The sodium concentration of the urine from exposed mice increased from 2.34 to 4.29 mg/ml, and the potassium concentration increased from 9.14 to 14.59 mg/ml. In a second study, mice approximately 9 months of age and weighing an average of 32.5 g were exposed to 5200 to 7200 Oe for 96 hr. The urinary sodium excretion from exposed mice increased from 3.26 to 6.25 mg per day and the potassium excretion increased from 7.81 to 14.44 mg per day. It is pointed out that experimental data indicate that the presence of a magnetic field imposes a stress either on the body as a whole or on certain body systems. (H.L.W.)

6646 MAGNETIC SUSCEPTIBILITY OF BIOLOGICAL MATERIALS. Senftle, F. E. (Geological Survey, Washington, D. C.); Hambright, W. P. pp 261-306 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

A review is presented of measurements of magnetic properties of biological materials that were made up to 1968. Studies on magnetic susceptibility included tumors and normal tissue, blood and serum, single cells, and sea urchin eggs and sperm. Studies on magnetic properties of blood and related compounds included porphyrin complexes, iron porphyrins, hemin, hematin, hemichromogen, ferroheme, hemochromogen, metalloporphyrins, hemoglobin, myoglobin, cytochromes, catalase, and peroxidase. Other compounds studied were copper proteins, ferredoxin, xanthine oxidase, ferrochrome, ferroverdin, ferritin, transferrin, chlorophyll, and vitamins. It was concluded that both paramagnetism and diamagnetism are large enough to cause significant orientation and distortion of the biological components when placed in a magnetic field. (H.L.W.)

6647 POSSIBLE LINK BETWEEN DIURNAL VARIATIONS IN RADIATION SENSITIVITY AND CELL DIVISION IN BONE MARROW OF MALE MICE. Pizzarello, Donald J.; Witcofski, Richard L. (Bowman Gray School of Medicine, Winston-Salem, N. C.). Radiology; 97: 165-7(Oct 1970).

Level of DNA synthesis and mitosis were measured at 6 a.m., 10 a.m., 2 p.m., 6 p.m., 10 p.m., and 2 a.m. in bone marrow of male Swiss Webster mice maintained on a 12-hr light, 12-hr dark cycle (lights on at 7 a.m.). Peak levels of DNA synthesis occurred at 10 p.m. and mitotic peak levels at 2 a.m., coinciding with previously observed peaks of total-body radiosensitivity following 800 and 900 R. Large numbers of cells in a critical organ in radiosensitive life-cycle stages may account for the lowered tolerance of radiation at these times. (auth)

6648 RADICALS FORMED IN PROTEINS BY REACTION WITH HYDROGEN ATOMS. Holroyd, Richard (North American Rockwell Corp., Canoga Park, Calif.); Glass, Joseph; Riesz, Peter. Radiat. Res.; 44: 59-67(Oct 1970).

Radical formation in the reactions of hydrogen atoms with some cystine-free proteins and polyalanine was investigated by both ESR and tritium-labeling techniques. The results showed that hydrogen atoms can cause chain cleavage as well as lead to the formation of carbon radicals. In the case of histone, a large proportion (67%) of the carbon radicals was on lysine residues. The distribution of radicals observed for hydrogen atom bombardment was similar to that observed in γ radiolysis for samples of histone, nagarse, and poly-DL-alanine. Reasons for this similarity were discussed. Exposure to hydrogen atoms produce α-carbon radicals in poly-DL-alanine and chain cleavage in poly-L-alanine, demonstrating that conformation affected the secondary radical distribution. (auth)

6649 EFFECT OF WHOLE-BODY X-RADIATION ON THE INCORPORATION OF ^{14}C-LYSINE IN NONPROLIFERATING AND PROLIFERATING TISSUES. Van Lancker, J. L.; Ariyama, K.; Chmura, C. (Brown Univ., Providence). Radiat. Res.; 44: 68-75(Oct 1970).

The effect of x radiation on the incorporation of ^{14}C-lysine into spleen, bone marrow, and intestinal mucosa nuclear and cytoplasmic proteins was compared to its incorporation into the same group of proteins, in kidney, liver, and brain. The results demonstrated that x radiation interferes with the incorporation of ^{14}C-lysine into nuclear protein and to a lesser degree into cytoplasmic proteins of actively proliferating tissues only. (auth)

6650 EFFECT OF 800 R THORACIC X-IRRADIATION ON LUNG TISSUE BIOCHEMISTRY. Tombropoulos, E. G.; Thomas, J. M. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res.; 44: 76-86(Oct 1970).

To study short-term biochemical effects on lung tissue, 1-mo.-old female rats were exposed to 800 R of thoracic x radiation. At different postexposure periods, lung tissues were examined for their ability to incorporate ^{14}C from (1-^{14}C) palmitate into lipids, and analyzed for their content of collagen, elastin, lipid, and lipid phosphorus. Irradiated rats showed an increased incorporation of ^{14}C from palmitate into lecithin and triglycerides by lung mitochondria from 14 to 24 hr postexposure, accompanied by an increase in total lung lipids, an increase in lung collagen hydroxyproline beginning at 4 days postexposure and lasting for 4 days and an increase in lung elastin hydroxyproline at eight days postexposure. (auth)

6651 RADICAL DISTRIBUTIONS IN γ-IRRADIATED DRY PROTEINS AT 195°K. Riesz, P.; White, F. H. Jr. (National Institutes of Health, Bethesda, Md.). Radiat. Res.; 44: 24-34 (Oct 1970).

Gamma radiolysis of dry proteins at 195°K in the presence of tritiated hydrogen sulfide gave information about the distribution of carbon radicals that were precursors in the secondary radicals observed at 298°K. When lyophilized ribonuclease, lysozyme, chymotrypsinogen, and nagarse (a protein without disulfide bridges) were irradiated at 195°K, the observed tritium distributions were approximately equivalent; however, at 298°K characteristic distributions were found. Thus, the mechanisms for the formation of carbon radicals in native proteins can be divided into two groups: first, those that took place below 195°K and were independent of amino acid sequence, conformation, and the presence of disulfide bridges; and second, those that occurred above 195°K and were influenced by the specific conformation of each native protein. (auth)

6652 REPAIR REPLICATION IN DIPLOID AND ANEUPLOID HUMAN CELLS. NORMAL REPLICATION REPAIRED DNA AFTER ULTRAVIOLET IRRADIATION. Painter, R. B.; Umber, J. S.; Young, B. R. (Univ. of California, San Francisco). Radiat. Res.; 44: 133-45(Oct 1970).

In human WI-38 (diploid) and HeLa S3 (aneuploid) cells, DNA that has undergone repair replication, as a result of uv-induced damage, can later participate in semiconservative synthesis. In WI-38, the fraction of DNA that did so was inversely proportional to the exposure to uv. In HeLa S3, however, no such simple relation holds; about two-thirds of the repaired DNA replicates normally irrespective of exposure up to 100 ergs/mm^2, with lower fractions doing so after higher exposures. There seem to be two kinds of repaired molecules after uv irradiation of HeLa S3: one in which the substituted bases occur in long runs; the other, in short runs only. Using cells synchronized by mitotic selection, evidence was presented for two rounds of semiconservative replication of repaired HeLa DNA. (auth)

6653 EFFECT OF γ-RAYS ON INFECTIVITY AND CAPACITY FOR NUCLEAR-ASSOCIATED AND CYTOPLASMIC DNA REPLICATION OF FV3 IN CHICK EMBRYO FIBROBLASTS. Aubertin, Anne-Marie; Decker, C.; Kirn, A. (INSERM, Strasbourg). Radiat. Res.; 44: 178-86(Oct 1970).

Irradiation by γ rays of purified FV3 led to a dissociation between the capacities for infectivity, for nuclear-associated (replicating) DNA, and for cytoplasmic DNA replication in chick embryo fibroblasts. When the amount of DNA synthesis induced by irradiated virus was expressed as a percentage of that induced by non-irradiated virus, the inactivation of the capacity for DNA replication (nuclear as well as cytoplasmic fraction) followed a simple exponential law. The rate of inactivation of the capacity for nuclear-associated DNA replication ($D_{37} = 8 \times 10^5$ R) was half that of the capacity for cytoplasmic DNA replication ($D_{37} = 4 \times 10^5$ R). This indicates that the synthesis of DNA which appears in the cytoplasm requires more cistrons than the synthesis of the nuclear-associated DNA, and that the passage from cytoplasmic DNA to the virions requires further protein synthesis. Irradiation with γ rays did not affect the capacity of FV3 for inhibiting host-cell DNA replication. (auth)

6654 HYDROGEN TRANSFER FROM EXCHANGEABLE TO CARBON-BOUND SITES IN γ-IRRADIATED DRY PROTEINS. Scher, Charles D.; Riesz, Peter (National Institutes of Health, Bethesda, Md.). Radiat. Res.; 44: 35-49(Oct 1970).

Gamma radiolysis in vacuo of dry ribonuclease and poly-DL-alanine, in which 40 to 60% of the exchangeable sites were tritium-labeled, led to the transfer of hydrogen from exchangeable to carbon-bound sites. Tritium incorporation is a linear function of dose from 5 to 30 Mrads. The G values for hydrogen transfer at 298°K are 3.0 for ribonuclease and 2.1 for poly-DL-alanine. The G values for ribonuclease at 195°K and 77°K are 0.7 and $\leq$0.1, respectively. There were many similarities between the distribution of tritium among the amino acids obtained by γ-irradiation-induced hydrogen transfer and that produced by the addition of tritiated

radical scavengers to previously γ-irradiated proteins. The latter was a measure of the secondary radicals produced at 298°K. Experiments with tritiated ammonia indicated that hydrogen transfer cannot be induced by secondary radicals after γ-radiolysis. For ribonuclease at 298°K, hydrogen is transferred with a G value which is approximately equal to the total initial radical yield. Hydrogen transfer continues in a dose region where the secondary radicals are at saturation level, and since it was shown that the species which incorporated tritium either corresponds to or was a precursor of the secondary radicals, it followed that for ribonuclease the rate of radical destruction was equal to the rate of radical formation in this dose region. (auth)

6655 CORRELATION OF RADIATION-INDUCED ULTRASTRUCTURAL CHANGES IN MOUSE HEPATOCYTES WITH ALTERATIONS IN PLASMA CONCENTRATION OF PROTEIN-BOUND NEUTRAL HEXOSES. Rene, Anthony A.; Evans, Adelbert S. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res.: 44: 224-36(Oct 1970).

Mice of strain C_3H were subjected to a whole-body dose of 530 rads of mixed gamma-neutron radiations delivered at a rate of approximately 20 rads/min. The blood plasma concentration of protein-bound carbohydrates, as neutral hexoses, was estimated daily after irradiation. Ultrastructural architecture of liver tissue taken from irradiated animals in extremis was compared with that of survivors and fed and starved unirradiated controls. Among the radioinduced differences, observed in the hepatocytes, were moderate to marked dilatation of the endoplasmic reticulum, increased Golgi activity, and rounding of the mitochondria with a decrease in numbers of mitochondrial granules. These alterations, together with other differences noted, were correlated with the increased plasma concentration of protein-bound neutral hexoses uniformly found in animals that succumb to radiation injury. (auth)

6656 RADIATION LESION OF GENE AND THE RECOVERY. Horikawa, Masakatsu (Kanazawa Univ., Japan). Farumashia; 6: No. 1, 10-14(Jan 1970). (In Japanese).

Recent progress in studies of the lesion of DNA in mammals induced by uv or x rays is reported. It was believed that uv lesion was caused by induced pyrimizine dimers, and X-ray lesion by the disruption of single and double strands of DNA. The formation of the dimer and the disruption of DNA were proved to depend upon the dose. Ehrlich cells have the ability to remove the dimer, but the L cells of a mouse and the PS cells of a pig do not. When L cells, PS cells, and Ehrlich cells were cultivated at 37°C for 30 to 60 min, the single strands of DNA, disrupted by x irradiation were recombined, but double strands were not. As for single strands, normal polynucleotides might work as a mold for the recombination, but double strands had no mold. Some misrepair in the process of the recombination may cause cancer or mutation. (NSA of Japan) (TSS)

Immunology

Refer also to abstracts 6719 and 6774.

6657 (CONF-691106-, pp 268-74) EFFECTS OF IRRADIATION ON THE CHANGES IN THE IMMUNE RESPONSE OF AGING MICE. Miller, M.; Jaroslow, B. N. (Argonne National Lab., Ill.).

From Symposium on neutrons in radiobiology, November 11-14, 1969, Oak Ridge, Tennessee.

Mice were given a single intraperitoneal injection of sheep red cells at different test ages (6 to 720 days). In each age group their spleens were removed at intervals up to 14 days after injection and the number of hemolysin-producing cells were determined by the Jerne Plaque technique. The curve of the number of direct and indirect plaque-forming cells in each group was obtained, and the time of peak production was determined. The maximum immune response occurred at 100 days of age and was higher in males than in females and remained higher up to 720 days of age. Groups of 100-day-old mice were given 25, 75, and 150 rads of neutrons from the Janus Reactor or were exposed to 50, 150, and 225 R of ^{60}Co γ-irradiation. The number of plaque-forming cells was determined at 100, 200, and 300 days post-irradiation. At this time there was no detectable difference in immune response in the irradiated animals when compared with normal animals of the same age. (auth)

6658 EFFECT OF A NONCELLULAR SPLEEN-DERIVED FACTOR ON RECOVERY OF HEMATOPOIETIC STEM CELLS FROM IRRADIATION. Knospe, William H.; Fried, Walter; Gregory, Stephanie Ann; Sassetti, Richard J.; Trobaugh, Frank E. Jr. (Rush Presbyterian-St. Luke's Hospital, Chicago). J. Lab. Clin. Med.; 76: 584-92(Oct 1970).

Implantation of irradiated mouse spleens into the peritoneal cavity of mice did not alter the number of hematopoietic stem cells in the femoral marrow when assayed by the spleen colony method. On the other hand, there was a significantly greater number of hematopoietic stem cells in femoral marrow of spleen-implanted mice as compared to those in saline-treated mice 4 days after exposure to 200 R of x irradiation (given 2 hr after spleen implants). Injections of homogenates made from spleens and of a water-soluble fraction of this homogenate similarly resulted in an increase in the rate of hematopoietic stem cell regeneration following 200 R. We postulate that a noncellular substance of splenic origin can increase stem cell proliferation in mice. Response to this stimulus is inhibited by the presence of a dense population of cells in the environment. (auth)

6659 GROWTH OF AN ALLOGENIC TUMOR IN LETHALLY IRRADIATED MICE TREATED WITH SENSITIZED AND UNSENSITIZED SPLEEN CELLS. Riches, A. C.; Thomas, D. Brynmor (Medical School, Birmingham, Eng.). Radiat. Res.; 44: 87-96(Oct 1970).

The growth of solid implants of a CBA mammary adenocarcinoma was followed in allogenic hosts. In untreated CS1 mice, the tumor was rejected briskly, whereas in animals exposed to single whole-body doses of 600 rads of x-irradiation, the tumor grew progressively. The capacity for allogenic tumor rejection in CS1 mice was depressed immediately after exposure to 820 rads of whole-body x irradiation and an intravenous injection of 25×10^6 spleen from syngeneic donors, but almost recovered after 1 month and completely recovered within 3 months. Animals treated, after exposure to 820 rads of whole-body x irradiation, with an equal number of spleen cells from a donor that had previously rejected an implant of the CBA tumor rejected the tumor implant briskly. Even after the administration of a lower dose (11×10^6) of sensitized spleen cells, the growth of the tumor was severely depressed. (auth)

Ecology

Refer also to abstracts 6316, 6598, 6620, 6698, and 6701.

6660 (BMI-171-44) POSSIBLE EFFECTS OF A SEA-LEVEL CANAL ON THE MARINE ECOLOGY OF THE AMERICAN ISTHMIAN REGION. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic-Pacific Interoceanic Canal. Martin, William E.; Duke, James A.; Bloom, Sanford G.; McGinnis, John T. (Battelle Memorial Inst., Columbus, Ohio). 15 Jul 1970. Contract AT(26-1)-171. 220p. Dep. CFSTI.

This preliminary study was undertaken to: summarize existing information concerning the marine ecology and physical oceanography of the isthmian region; describe the marine habitats and biotic communities on both sides of the Isthmus; develop preliminary mathematical models to simulate the physical and biological mixing processes that could take place through a sea-level canal; predict the possible economic and ecological consequences of these processes; and recommend further field, laboratory, and modeling studies needed to improve such predictions. With the limited ecological information available, it is possible to predict precisely the specific ecological consequences of marine mixing via a sea-level canal. Preliminary modeling studies indicate that the net flow of water would be from the Pacific to the Atlantic. This would result in minor environmental changes near the ends of the canal and near shore east of the Atlantic terminus. Passive migration of planktonic organisms would occur almost entirely in the same direction. Active migration of nekton could occur in either direction, but environmental conditions in the canal would favor migration from the Pacific to the Atlantic. No evidence was found for predicting ecological changes that would be economically deleterious to commercial, sport, or subsistence fisheries. No evidence was found to support the prediction of massive migrations from one ocean to another followed by widespread competition and extinction of thousands of species. Evidence currently available appears to indicate a variety of barriers to migration of species from one ocean to another and/or the subsequent establishment of successful breeding colonies in the latter. It is highly improbable that blue-water species like the sea snake and the crown-of-thorns starfish could get through the canal except under unusual circumstances. On the other hand, we can be fairly certain that some Pacific species could transit the canal and become locally established in the Pacific waters of the Atlantic. To improve the precision and reliability of these and similar ecological predictions would require additional information and quantitative data that could be provided only by a comprehensive program of field, laboratory, and theoretical (modeling) studies. (E.R.B.)

6661 (BNWL-SA-3203) QUANTITATIVE EVALUATION OF ENVIRONMENTAL FACTORS AFFECTING POPULATION EXPO-

XUM

SURE NEAR HANFORD. Honstead, J. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [May 1970]. Contract AT(45-1)-1830. 18p. (CONF-701106-3). Dep. NTIS.

From Symposium of the Health Physics Society, Idaho Falls, Idaho.

Radioactivity from a nuclear installation that reaches the nearby populated environment may be evaluated in terms of the resulting population dose. The combined effect of exposure to external radiation sources and internal deposition of radioactivity must be calculated. The calculation requires analysis of a complex system of exposure pathways which are controlled by the nature of the environment, the radionuclide mix involved, and the habits, occupations, and distribution of the people affected. The environmental evaluations performed at Hanford estimate the annual dose received by people living near the site. The estimated average whole-body dose decreased from 18 mRem per year in 1964 to 5 mRem per year in 1968 as several Hanford production reactors were shut down. Hanford radioactivity reaches populated areas by way of the Columbia River and by transport with and deposition from the atmosphere. The local population is distributed through irrigated rural areas downstream and downwind from Hanford and in downstream communities using the river for sanitary water and recreation. The diet and recreation habits of various population groups have been studied through special surveys and related to the resulting dose received by these people. (auth)

6662 (BNWL-SA-3552) COCARCINOGENIC STUDIES IN PULMONARY CARCINOGENESIS. Park, J. F.; Howard, E. B.; Stuart, B. O.; Wehner, A. P.; Dilley, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1970]. Contract AT(45-1)-1830. 33p. (CONF-700501-1). Dep. NTIS.

From Conference on Morphology of Experimental Respiratory Carcinogenesis, Gatlinburg, Tenn.

Cocarcinogenic experiments are currently in progress to determine the pathogenesis of several potentially carcinogenic materials on the induction of pulmonary neoplasia in experimental animals. The role of ^{239}Pu induced lymphopenia and lymphatic pathology is being evaluated in the pathogenesis of pulmonary neoplasia induced by inhalation of plutonium dioxide in beagle dogs. Hamsters and dogs are being exposed to combinations of uranium mine air contaminants including radon daughters, uranium ore dust, diesel engine exhaust, and cigarette smoke. The cocarcinogenicity of inhaled asbestos, nickel oxide, cobalt oxide, and cigarette smoke is being investigated in hamsters. (auth)

6663 (FOA-4-4435) STUDIES ON THE TRANSPORT OF FISSION PRODUCTS THROUGH FOOD CHAINS. II. ^{137}Cs IN SWEDISH GRAIN CROPS, 1962-1967. Fredriksson, L.; Eriksson, A.; Haak, E.; Soederman, O.; Auraldsson, H.-A. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Aug 1970. 31p. Dep. CFSTI (U. S. Sales Only).

During 1962 to 1967, the ^{137}Cs content of about 1700 representative samples of Swedish cereals was determined. The cesium content of the grain reached its peak mean value, 875 pCi ^{137}Cs per kg, in 1963. Thereafter, the contamination decreased roughly by one-half every year. Rye had about 70% higher Cs content than the other cereals. Regional differences in the contamination level of the cereals were found. These could be explained by differences in the amount of fallout and its distribution in time during the vegetation period combined with regional differences in crop development as related to seasonal changes of the fallout rate. (auth) (SW)

6664 (TID-3910(Suppl.6)) TERRESTRIAL AND FRESHWATER RADIOECOLOGY. A Selected Bibliography. Klement, Alfred W. Jr.; Schultz, Vincent (Washington State Univ., Pullman. Dept. of Zoology). Dec 1970. Contract AT(45-1)-2221. 201p. Dep. NTIS.

A list of 2314 references to recent publications in the world literature and 23 bibliographies covering environmental radioactivity, tracer techniques for studies of terrestrial and freshwater ecosystems, the effects of radioactive waste disposal on ecosystems, and related studies of terrestrial and freshwater radioecology is presented. (C.H.)

6665 (UCD-472-117, pp 112-13) ^{137}Cs ACCUMULATION IN 3 SUBPOPULATIONS OF COLUMBIAN BLACK-TAILED DEER (ODOCOILEUS HEMIONUS COLUMBIANUS). Book, S. A.; Connolly, G. E.; Longhurst, W. M. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

The fallout ^{137}Cs concentration in rumen contents and muscle of deer inhabiting oak woodland, chaparral subjected to controlled burning, and virgin chaparral was investigated in relation to distribution and availability of preferred forage. (auth)

6666 ECOLOGY AND RADIATION EXPOSURE OF KANGAROO RATS LIVING IN A TRITIATED ENVIRONMENT. Hatch, F. T.; Mazrimas, J. A.; Koranda, J. J.; Martin, J. R. (Univ. of California, Livermore). Radiat. Res.: 44: 97-107(Oct 1970).

Kangaroo rats (Dipodomys ordii) living near a crater resulting from a nuclear detonation were found to be generally tritiated. The tritium activity of body water and tissues ranged from 0.1 to 0.4 μCi per gram. Organically bound tissue tritium had approximately the same specific activity as body water ($6-8 \times 10^6$ dpm per gram hydrogen). The animals appeared to be in equilibrium with their food supply and the soil, in terms of tritium concentration. The lifetime chronic radiation dose to adult animals was estimated to be 10 rad from internal ^3H. About 10 rad was also received from persistent external β- and γ-emitting radionuclides in the soil. There was no significant concentration of other internal radionuclides. The generalized tritium labeling and chronic low-level radiation exposure are of special interest in these animals. There was no macroscopic evidence of harmful radiation effects. (auth)

6667 ENVIRONMENTAL EFFECTS OF PRODUCING ELECTRIC POWER. PART 1. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, FIRST SESSION, OCTOBER 28, 29, 30, 31, NOVEMBER 4, 5, 6, AND 7, 1969. Washington, D. C.; Joint Committee on Atomic Energy (1969). 1114p. GPO $4.50.

A record of the hearing dates, AEC witnesses, statements of witnesses, and additional material submitted for the record are presented. Press releases, letters, published articles, and additional reports related to the subject of the commission hearings are presented in 19 appendixes. (E.R.B.)

Genetics and Cytogenetics

Refer also to abstracts 6640, 6689, 6766, 6774, and 6811.

6668 (CONF-691106-, pp 280-96) MUTAGENICITY VERSUS RADIOSENSITIVITY: TARGET CONSIDERATION. Kondo, Sohei; Ichikawa, Haruko; Ishii, Yutaka; Kato, Takesi (Osaka Univ. (Japan). Dept. of Fundamental Radiology).

From Symposium on neutrons in radiobiology, November 11-14, 1969, Oak Ridge, Tennessee.

The radiobiological process is classified into three stages: radiation physico-chemical (V and d); biochemical (r); and biological (f). Dose (D) effect curves for survival S and mutation frequency F were extracted from experimental data with E. coli strains possessing different DNA repair capacities and analyzed in terms of the above-mentioned three stages. For uv effects, the target is DNA, d is known and both r and f can be varied by using different types of repairless mutants. In this way, from the experimental set of λ and μ values, estimation of V, r, and f was made. Similarly, x ray data were analyzed by assuming that d is approximately equal to ion density. It was concluded that deletion mutations are more frequently induced than point mutations by x rays but the reverse is the case with uv and that point mutations are not inducible in an x-ray sensitive and recombination-defective mutant but deletion mutations are. Based on these conclusions, mutation data in higher organisms are analyzed and biological factors involved in the RBE vs. LET relationships are discussed. (auth)

6669 (CONF-691106-, pp 297-312) MUTATION IN QUANITATIVE TRAITS INDUCED BY NEUTRON IRRADIATION. Brock, R. D. (Commonwealth Scientific and Industrial Research Organization, Canberra (Australia)).

From Symposium on neutrons in radiobiology, November 11-14, 1969, Oak Ridge, Tennessee.

The spectrum of effects in quantitatively inherited traits in higher plants produced by neutrons is remarkably similar to those produced by other mutagens. The efficiency of neutrons in inducing chromosomal changes compared with some chemical mutagens is discussed. It was concluded that either a large proportion of the changes in quantitatively inherited characters are chromosomal structural changes rather than gene mutations, or that selection processes operate to remove the excess of chromosomal changes after neutron treatment. In either case neutrons induce potentially useful mutations in quantitatively inherited characters. (auth)

6670 (CONF-691106-, pp 315-39) NEUTRON-INDUCED GENETIC EFFECTS: A REVIEW. Bender, Michael A. (Oak Ridge National Lab., Tenn.).

From Symposium on neutrons in radiobiology, November 11-14, 1969, Oak Ridge, Tennessee.

The RBE values for dominant and recessive lethal mutations induced in animals and in microorganisms by fast neutrons of various energies range from approximately one to four. Higher

RBE values for plant material are taken as evidence that in plants most mutations are actually chromosomal aberrations. Neutrons do not appear to produce a mutation spectrum different from that for x or γ rays. In contrast to the power-law kinetics observed with acute doses of x or γ rays, neutrons induce multiple-break chromosomal aberrations as a linear function of dose. RBE values are thus a function of the dose given. At very low dose rates multiple-break aberration curves for x and γ rays become nearly linear. RBE values for exposures at low dose rates may become as high as 100. For single-break chromosomal aberrations that display approximately linear dose-effect kinetics for acute doses of either neutrons or x and γ rays, RBE values in the range of 2.5 to 13 are reported for various plant and animal systems. RBE is found to be dependent on neutron energy, lower energy neutrons yielding higher RBE values. Thermal neutrons deposit energy in tissue by capture rather than by production of a recoil proton, making determination of their relative effectiveness dependent on precise determinations of the energy deposited from proton and α particle production and from prompt and delayed β particle and γ ray production. Determination of thermal neutron RBE for chromosomal aberration production yields values about three times greater than would be expected from the same doses of the various capture radiations given externally. The RBE for mutation production appears to be similar to that for fast neutrons. (auth)

6671 (CONF-691106–, pp 340-8) GENETIC EFFECTS IN MICE OF PROTRACTED NEUTRON DOSES: SOME RECENT FINDINGS. Searle, A. G.; Phillips, Rita J. S. (Medical Research Council, Harwell (England). Radiobiological Research Unit).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

The induction of specific locus recessive and dominant visible mutations in mice by chronic neutron and gamma exposures were studied in germ-cells most at risk in the two sexes, namely spermatogonia and dictyate oocytes. While in the male fast neutrons were about 20 times as effective as γ rays, both types of radiation were genetically very ineffective in the female so that no RBE could be estimated. The genetic radiosensitivity in male and female mice of similar embryonic germ-cells were compared by giving week-long doses of fast neutrons to female mice in early pregnancy. Germ-cells concerned were mitotically dividing oogonia and primordial spermatogonia, and their precursors. Some large clusters of mutant offspring were obtained in contrast to the scarcity of clusters when germ-cells were irradiated in the adult. Estimated mutation frequencies were very similar in the two sexes, which suggests that there is no intrinsic difference between them in genetic radiosensitivity. Where pre-meiotic male germ-cells were irradiated, descendant primary spermatocytes at diakinesis and metaphase were scored for the presence of multivalent configurations indicative of translocation heterozygosity. The results were used to obtain an estimate of the expected frequency of radiation-induced translocations causing semi-sterility or sometimes full sterility and of secondary dominant lethality in the offspring of these males. (auth)

6672 (CONF-691106–, pp 349-72) CURRENT RESEARCH IN NEUTRON-IRRADIATION EFFECTS ON PLANT CHROMOSOMES. Preston, R. J. (Medical Research Council, Harwell (England). Radiobiological Research Unit).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Using the germination of Tradescantia pollen as a measure of survival, it was shown that lack of ability to germinate following x- or neutron-irradiation can be closely correlated with the presence of chromosome fragments. This system is being employed to investigate a variety of radiobiological phenomena where response to neutrons contrasts with response to x rays. One such contrast in Tradescantia is found in the saturation of the dose response curve for chromosome exchange aberrations. Obvious evidence of saturation is found after neutron-irradiation. The induction of chromatid aberrations by 14.1 MeV neutrons in Vicia faba root meristem cells was studied. The frequency of aberrations throughout G_2 and during late S was observed, showing that there is a peak of sensitivity in early to mid G_2 and a decline in S. Detailed analysis of the relative frequencies of the various chromatid interchange types, compared with those found after x irradiation, revealed a number of important differences, and at the same time provided information about the effective LET of these neutrons. (auth)

6673 (RLO–2221-T-2-3) COMPARATIVE STUDIES OF THE BIOLOGICAL EFFECTIVENESS OF NITROGEN MUSTARDS, ETHYLENIMINE, AND GAMMA RAYS. Nawar, M. M.; Konzak, C. F.; Nilan, R. A. (Washington State Univ., Pullman. Dept. of Agronomy and Soils). [1970]. Contract AT(45-1)-353. 17p. Dep. NTIS.

An exploratory study of the differential effectiveness and efficiency with which a group of structurally related aliphatic nitrogen mustards, ethylenimine, and γ rays induce biological, especially genetic, changes in barley following seed treatment was made. Results showed that the polyfunctional nitrogen mustards were markedly more effective in depressing growth and breaking chromosomes than were the monofunctional nitrogen mustard or ethylenimine. The monofunctional chemicals induced high levels of chlorophyll-deficient mutations whereas polyfunctional nitrogen mustards elicited only a few such mutations. The low level of chlorophyll-deficient mutations resulting from treatments with polyfunctional nitrogen mustards was probably caused by the elimination of cells carrying potential genetic changes for such mutations during the early stages of ontogeny, rather than to the inability of these chemicals to induce the initial lesions for chlorophyll-deficient mutations. Gamma ray treatments induced high frequencies of both chromosomal aberrations and chlorophyll-deficient mutations with comparatively less growth depression. The ratio of dicentric bridges to acentric fragments, observed at the first anaphase following treatment, was much higher for gamma rays than for any of the chemicals. (auth)

6674 (RLO–2221-T-2-5) NATURE, INDUCTION, AND REPAIR OF RADIATION-INDUCED GENETIC DAMAGE IN PLANTS. Annual Progress Report, November 1, 1969–October 31, 1970. Nilan, Robert A.; Konzak, C. F. (Washington State Univ., Pullman). 15 Nov 1970. Contract AT(45-1)-2221. 15p. Dep. NTIS.

The effects of γ radiation on seeds or isolated embryos of barley were studied. Emphasis was placed on studies on the modification of radioinduced chromosome aberrations by sodium azide, the relationship between mutations and chromosome aberrations during mitosis and meiosis, the development of a method for isolation and characterization of DNA from barley, and the in vitro and in vivo effects of ionizing radiation on gibberellic acid. (C.H.)

6675 (UCD–472-117, pp 101-2) IN VITRO X-IRRADIATION EFFECTS ON CULTURED MARMOSA MITIS LYMPHOCYTES. Wolf, H. G.; Klein, A. Kimi; Foin, Angela T.; McCullough, J. M.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Peripheral lymphocytes from Marmosa mitis (2N = 14) were given 50 to 500R irradiation at 50R/min. First mitosis metaphase cells were harvested from PHA-stimulated cultures. Microscopic evaluation indicated the probability of a break in an individual chromosome to be proportional to the length of that chromosome minus a non-reactive centromeric region. Dicentric composition was not predictable according to chromosome length. The number of dicentrics found at a given radiation dose was lower than in human cell studies, suggesting a relation between dicentric formation and the number of chromosomes. (auth)

6676 MUTAGENIC EFFECTS OF MAGNETIC FIELDS ON DROSOPHILA MELANOGASTER. Tegenkamp, T. R. (Otterbein Coll., Westerville, Ohio). pp 189-206 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

Magnetic fields of lesser or greater strength than that of the geomagnetic background, whether with fields of large or small gradient, induce mutations affecting the sex ratios of Drosophila melanogaster. It was not ascertained whether these mutations are sex-linked or autosomal in nature. The mutagenic effects of magnetic fields on genes controlling traits unrelated to sex also have been demonstrated. Mutations resulted in withered wing, convergent banding, and spotted abdomen, which were without sex-linked inheritance. It appears that only a few DNA synthesis fibrils are affected by the magnetic field utilized, judging from the number of inbreeding generations before the appearance of anomalies. There appears to be a healing effect of some of the mutations induced by magnetic treatment. The concept that the reversal of the geomagnetic field alone, by virtue of passing through a zero and near-zero intensity, may be a contributing factor for stages in evolutionary development has been proposed. (auth)

6677 MORPHOLOGICAL AND CYTOLOGICAL EFFECTS OF SINGLE AND COMBINED TREATMENTS OF X-RAYS AND COLCHICINE ON TOMATO (LYCOPERSICON ESCULENTUM MILL). Bose, S.; Banerjee, B. (Univ. of Calcutta). J. Indian Bot. Soc.; 48: 268-74(1970).

The modification of morphological and physiological effects of treatments of irradiated seeds with colchicine was studied, and single treatments of these two mutagenic agents were compared. Seeds of tomatoes (var. Ponderosa) were given single and combined treatment of x rays (10 and 20 kR) and colchicine. Morphological variations and mitotic and meiotic irregularities were

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studied in the M_1 generation. No definite pattern could be observed for data taken for a number of characters. Fasciation and bifurcation of stem were observed in plants originating after some of the treatments. None of the colchine-treated series showed bigger size of stomata and there was no indication of polyploid induction. Stickiness and clumping of chromosomes were noticed in the mitotic cells of some of the treated series while meiotic irregularities like univalent, trivalent, quadrivalent, and fragments were noticed at metaphase I in most of the treated series. In addition to this, laggards and bridges with or without fragments were observed at anaphase I; bridges, mostly without fragments, were also noticed at anaphase II. Factors responsible for the origin of morphological variations and mitotic and meiotic irregularities have been pointed out. The significance of the finding of translocation and inversion and their importance are discussed. (auth) (India)

6678 RADIOSENSITIVITY OF CONIDIOSPORES TO THERMAL NEUTRONS AND ISOLATION OF MUTANTS OF TRICHODERMA GLAUCUM ABBOTT. Dnyansagar, V. R.; Khatri, A. A. (Inst. of Science, Bombay). Indian J. Exp. Biol.; 7: 31-3(Jan 1969).

Spore suspensions of Trichoderma glaucum were irradiated outside the core of the reactor as well as in the thermal cavity with the neutron flux varying from 10^{12} to 30×10^{12} n/cm^2/sec in the core area and from 10^7 to 10^8 n/cm^2/sec in the thermal cavity. The spores were killed exponentially with increasing dosages. Thermal neutrons induced morphological nutritional mutants. The morphological mutants exhibited a wide range of characters and synthesized lesser quantity of gliotoxin as compared to the wild strain. (auth)

6679 GENETIC X-RADIATION DAMAGE TO DROSOPHILA GERM CELLS UNDER DIFFERENT CONDITIONS. Yoon, Jong Sik (Yonsei Univ., Seoul). Yonsei Med. J.; 10: 25-36(1969).

Drosophila melanogaster (Oregon-R, Oak Ridge strain) males, 19 to 21 hours old, were x-rayed with a total dose of 1000 R or 3000 R given in two equal fractions of 500 R or 1500 R at a dose rate of 500 R per minute, or they were given a single dose of 1000 R at 24 ± 1°C in several gas environments, with a time interval of 40 minutes between the two doses. At each change of gas(es), the system was evacuated to remove all gases, then flushed with helium for 1 minute. Tests using CO were carried out in the dark and the others in the light, both at 1 atmosphere of the gas or gas mixture. In order to study the genetic radiation damage and its modification by several gases the frequencies of dominant lethals and translocations induced in cells which were in different stages of spermatogenesis were scored using seven sequential 2-day matings over a two-week test period. Data are presented which indicate that: The frequency of dominant lethals increased from sperm to spermatids and meiotic cells, then decreased in spermatogonial cells which were the least susceptible to x rays. The cycle of damage for dominant lethals is similar to that for translocations, but does not coincide with it completely, and the peaks of damage for both are located in the early postmeiotic stages, and the cycle of frequencies of translocations coincides with that of percentages of sterility of F_1. The coincidence of frequencies between translocations and the sterility demonstrates that the mechanisms of damage for both are related, at least in part. The NO effect on sperm and late spermatids is more drastic than the oxygen effect, but a major fraction of the effect is to cause the death of the sperm. The carbon monoxide (CO) during radiation increase genetic damage above the other gases tested, and it is possible to conclude that the duration(s) of 4 min of gases in post treatments is too short to modify the damage. There are few (or no) translocations recovered from premeiotic cells. The Y chromosome was involved in 10.8% of total breaks, or about ¼ as frequently as the two autosomes tested, and chromosomes 2 and 3 equally participated in an interchange. (auth)

6680 INDUCTION OF CHROMOSOME ABERRATIONS BY X-RAYS AND CHEMICAL MUTAGENS IN A DESYNAPTIC MUTANT AND IN WILD-TYPE BARLEY. Swietlinska, Z.; Evans, H. J. (Univ. of Aberdeen, Eng.). Mutat. Res.; 10: 185-96 (Sep 1970).

It was previously proposed that eukaryotes with a genetically determined abnormality in the sequence of events leading to normal chromosome exchange at meiosis might be expected to show an altered response on the part of their somatic cell chromosomes following exposure to chemical or physical mutagens. As part of a program undertaken to examine this contention, dry and soaked seeds of a wild-type (Ds Ds) and a desynaptic mutant (ds ds) of barley were exposed to x rays and the frequency of chromosome type aberrations determined in cells in their first post irradiation mitosis. Seeds and root tips were also exposed to the chemical mutagens nitrogen mustard and diepoxybutane and a detailed analysis of the induced chromatid type aberrations revealed no difference in the sensitivity of ds ds and Ds Ds genotypes. The frequency of sister chromatid exchange was studied in autoradiographs of root tip cells in their second mitosis following exposure to [^{3}H] thymidine. There was no difference in the incidence of such exchanges between cells from the different genotypes. (auth)

6681 SENSITIVITY AND INDUCTION OF MUTATIONS IN SORGHUM. Ramulu, K. Sree (Agricultural Coll. and Research Inst., Coimbatore, India). Mutat. Res.; 10: 197-206(Sep 1970).

The effect of physical (x and γ rays) and chemical (ethyl methanesulphonate (EMS), methyl methanesulphonate (MMS), diethyl sulphate (DES), and N-nitroso ethyl urea (NEU)) mutagens and combination treatments was studied on germination, survival, seedling growth, pollen and seed fertility in M_1, and frequency of chlorophyll mutations in M_2 of sorghum. The percentage of germination survival, and growth of seedlings decreased with an increase in dose of the mutagens. Gamma rays produced greater reduction in germination, survival, and seedling growth than the other mutagens. MMS caused more drastic effects than the other chemical mutagens. Combination treatments showed an enhanced effect when compared with single treatments. A linear dependence of pollen and seed fertility on dosage was evident in all three varieties. EMS caused more drastic effects on fertility than did the other mutagens. The mutagens affected fertility on both male and female phases, and the change in fertility status in the male and the female sides was found to be interdependent. Besides a linear relationship of chlorophyll mutation frequency with dose, a saturation effect was observed. EMS was found to be the most potent mutagen in inducing the chlorophyll mutations. The low potency of NEU and MMS was due to their high toxicity. The frequency of chlorophyll mutations was found to depend not only on the type of mutagen and dose but also on the genotype constitution of the material used. (auth)

6682 CYTOGENETIC STUDY OF RADIATION DAMAGE IN ENTIRE GENOMES OF DROSOPHILA. Valencia, Ruby M. (Oak Ridge National Lab., Tenn. Atomic Energy Commission, Buenos Aires. Univ. of Wisconsin, Madison). Contract AT(11-1)-1748. Mutat. Res.; 10: 207-19(Sep 1970).

Adult Drosophila melanogaster males, aged 1 to 2 days, were x-irradiated with 4000 R and mated for approximately 48 hr to females containing genetic markers and/or cross-over suppressors in all chromosomes. F1 females of the desired genotype were collected and appropriate genetic schemes followed to arrive at balanced stocks of entire treated genomes. Each chromosome of each genome was observed for visibles, lethals, sterility factors, and extreme detrimentals. All chromosomes of each genome were examined cytologically for deficiencies, inversions, transpositions, etc., and to determine the breakpoints of translocations, previously detected genetically. Of the 310 genomes analyzed, 63.2% were found to contain genetic damage. It can be calculated that approximately 2265 genomes were actually irradiated, of which 10.7% transmitted genetic damage to succeeding generations. Inherited damage was tabulated in terms of damaged sites, a site being either a point mutation or a chromosome break. The number of sites in any particular genome varied from 1 to 6, there were on the average 1.12 sites per genome, and the average number of sites per chromosome was found to be related to mitotic length. Analyses were made of the interrelations of the different types of damage by tabulating rearrangements according to cytological nature, viability, fertility, and phenotypic expression, of recessive lethals according to cytological nature, and of visibles according to cytological nature, viability, and fertility. (auth)

6683 INTERACTION OF MUTATIONAL LESIONS INDUCEL BY ETHYL METHANESULPHONATE AND γ-RAYS IN MALES OF DROSOPHILA. Sharma, R. P.; Grover, R. Prakash (Indian Agricultural Research Inst., New Delhi). Mutat. Res.; 10: 221-6 (Sep 1970).

Gamma irradiation and EMS treatment enhanced the frequency of sex-linked recessive lethals and translocations in Drosophila males. The mutation frequency observed in the combined treatments was significantly greater than that obtained by adding the frequencies produced by the two treatments individually. The synergism in mutation frequency was not due to the selective elimination of some of the cell stages but to a higher proportion of mutated sperm per affected male. It is suggested that the increase in mutation frequency was due either to a more efficient induction of premutational lesions by EMS or to a more efficient fixation of these lesions by post EMS treatment. Under the treatment conditions used, EMS did not induce translocations in mature spermatozoa, but when combined with γ rays, the translocation frequency increased significantly over that produced by γ rays

alone. These results were interpreted to mean that post EMS treatment somehow checks the repair of radiation-induced breaks and thus increases the chance of their rejoining. (auth)

6684 INFLUENCE OF DNA CONTENT AND NUCLEAR VOLUME ON THE FREQUENCY OF RADIATION-INDUCED CHROMOSOME ABERRATIONS IN BUFO SPECIES. Griffin, C. S.; Scott, D.; Papworth, D. G. (Medical Research Council, Harwell, Eng.). Chromosoma; 30: 228-49(1970).

The frequency of chromosome aberrations was compared in x-irradiated blood lymphocytes of Bufo marinus, B. calamita and B. pardalis which have similar chromosome numbers (2n = 22) and karyotypes but differ in chromosomal DNA content and nuclear volume. For each species the yield, per cell of centric exchange aberrations (dicentrics + rings) and of deletions (interstitial and terminal) increased approximately as the 1.5th power of the dose. The 55% higher chromosomal DNA content of B. pardalis compared with both B. marinus and B. calamita resulted in the same increase in the frequency of deletions as a 55% increase in radiation dose, approximately doubling the yield. Both factors probably lead to a similar increase in the frequency of primary lesions from which the deletions are derived. In contrast, an increase in chromosomal DNA content did not result in a higher yield of dicentric and ring exchanges, probably because the greater nuclear volume of B. pardalis (twice that of the other species) offset the potential increase in exchanges by increasing the average distance between chromosomes and chromosome arms. The data support the hypothesis that, in order to be involved in exchange, chromosome regions must be close together at the time of irradiation. The frequency of deletions is unaffected by changes in nuclear volume. (auth)

Health Physics and Safety

Refer also to abstract 6280.

Radioactive Contamination and Decontamination

Refer also to abstracts 6619, 6621, 6663, 6664, 6667, 6701, 6809, and 7778.

6685 SIZE-SELECTIVE SAMPLING OF PLUTONIUM AND URANIUM AEROSOLS. Ferran, G. H.; Hyatt, E. C. (Los Alamos Scientific Lab., N. Mex.). Amer. Ind. Hyg. Ass. J.; 31: 282-9 (May-Jun 1970).

A study was made to characterize aerosols of plutonium and uranium with a two-stage, size-selective sampler. The first plutonium area was sampled with a LASL-type cyclone air sampler using a membrane filter as a second stage with an adjacent membrane filter as a gross sampler. Gross and second-stage samples were alpha-counted to determine the respirable fraction of airborne material. The second plutonium area and the uranium area were sampled with paired HASL-type ½-inch cyclone samplers using membrane filters as a second stage. By analyzing material collected in the cyclone and on the second stage, the fraction of the sampled material in the respirable range was calculated. The results of sampling the second plutonium area with HASL-type ½-inch cyclones at flow rates of 18 and 9 liters/min indicate that both sampling rates give similar values for percent respirable for this fine aerosol. Particle size measurements on these samples were made by alpha track counting and with a light-field microscope. (auth)

6686 EXPERIMENTAL STUDY OF ^{242}Cm CONTAMINATION AND TREATMENT. Nenot, J. C.; Morin, M.; Lafuma, J. (CEA, Fontenay-aux-Roses, France). Health Phys.; 18: 613-22(Jun 1970). (In French).

Curium-242 is relatively little known from the biological point of view; a parallel between both its chemical and biological properties was set and a comparison with elements of the same family such as ^{239}Pu or other families such as rare earths was made. A metabolic study of a ^{242}Cm solution injected locally showed that degradation was rapid and the distribution of the metabolized portions remained always the same; experiments were highly reproducible. DTPA-therapy of intramuscular contaminations demonstrated the stability of the ^{242}Cm-DTPA complex and specified the importance of the chelating agent as a protector of the skeleton. Efficiency was directly dependent on early therapy. It was therefore possible from this study to determine a therapeutic procedure applying to human contamination cases. (auth) (UK)

Dosimetry and Monitoring

Refer also to abstracts 6533, 6539, 6582, 6630, 6661, 6666, 6717, 6748, 6750, 7788, 7980, and 8125.

6687 (ANL-Trans-864) EXPERIMENTAL BASIS FOR MAXIMUM ALLOWABLE LOAD (MAL) OF ^{239}Pu IN THE HUMAN ORGANISM, AND MAXIMUM ALLOWABLE CONCENTRATION (MAC) OF ^{239}Pu IN AIR AT WORK LOCATIONS. Buldakov, L. A.; Lubchanskii, E. R. Translated for Argonne National Lab., Ill., from a Russian report. 32p. Dep. NTIS.

Recently gathered experimental data regarding the biological effect of plutonium-239 with various routes and rhythms of accumulation in the organism, as well as information regarding the behavior of the emitter in the organism and its microdistribution in the lungs, raises the question of the need for reexamining existing norms for MAL and MAC. On the basis of data obtained, the following recommendations are made: decrease the MAL of plutonium-239 in the organism for professional irradiation (soluble compounds) from 0.04 μCi to 0.01 μCi, i.e., four-fold; decrease the MAL of plutonium-239 in the lungs from 0.016 μCi to 0.0016 μCi, i.e., ten-fold; decrease the MAC of plutonium-239 in the air of work locations from 2.10^{-15} Ci/l to 5.10^{-16} Ci/l, i.e., four-fold; establish a norm for maximum allowable accumulation of plutonium-239 in the human organism through the respiratory route at a value of $1.25 \cdot 10^{-3}$ μCi/year or 3.10^{-4} μCi/quarter. (auth)

6688 (BNWL-1489) IN-PHANTOM DOSIMETRY OF ^{238}Pu HEAT SOURCES IN RELATION TO CIRCULATORY SUPPORT SYSTEMS. Cross, F. T.; Sheppard, J. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1970. 48p. Dep. CFSTI.

The dose rates from an implanted ^{238}Pu heat source were measured and calculated. The source material was medical grade plutonium of nominal 30 W strength. The tissue-equivalent phantoms were both a large homogeneous right-circular cylinder and a Remab phantom. Calculated dose rates agreed to within 20% with measured values except for positions very close to the source. The reasons for discrepancies greater than this are stated in the text, and, in brief, are thought mainly to arise from the uncertainties in the photon emission rate and the use of dosimeters too large for neutron measurements close to the source In general, the agreement of the measured and calculated values is good, at least in the regions where the photons and neutrons make their greatest dose contribution for a source enclosed in a circulatory support system. (auth)

6689 (CONF-691106) SYMPOSIUM ON NEUTRONS IN RADIOBIOLOGY, NOVEMBER 11–14, 1969, OAK RIDGE, TENNESSEE. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn. Oak Ridge National Lab., Tenn.). 596p. Dep. CFSTI $10.00.

Thirty-five papers were presented. Twenty-nine separate abstracts were prepared. The remaining six papers of the conference were previously abstracted separately for NSA. (H.B.G.)

For abstracts of individual papers see: 6633–6635, 6657, 6668–6672, 6690–6696, 6748, 6749, 6760–6763, 6769–6773, 6803, and 6810.

6690 (CONF-691106-, pp 3-11) DOSIMETRY OF MIXED FIELDS OF NEUTRON AND GAMMA RADIATION: A REVIEW. Williamson, Frank S. (Argonne National Lab., Ill.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Techniques for the dosimetry of γ and neutrons in mixed fields are discussed. Emphasis is placed on those most commonly used and that require the smallest investment in special equipment and technology. The concepts of kerma, and of absorbed dose, provide quantities that are sufficiently well defined for the purpose of physical measurement, though they fall far short of the real need for a quantity that is closely related to biological effect. Detailed information on the neutron spectrum, and possibly also the gamma spectrum, of the mixed field should also be obtained and may even be necessary in order to correct instrument response. There is a great deal to be gained by using a multiplicity of techniques of diverse characteristics. In this way the deficiencies of one may be offset by the advantages of another. (auth)

6691 (CONF-691106-, pp 12-27) NEUTRON DOSIMETRY WITH TISSUE EQUIVALENT CHAMBERS. Goodman, Leon J. (Columbia Univ., New York. Radiological Research Lab.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Three applications of tissue equivalent ionization chambers to neutron dosimetry are discussed. The first deals with a gas flow chamber containing a disc-shaped collection volume and is used to measure depth dose in a human-size phantom and secondary particle build-up. Data obtained in connection with dosimetry studies for a fast neutron therapy beam are presented. The second application is the use of internal gas multiplication with tis-

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sue equivalent chambers. This technique can yield chamber currents as high as about a million times greater than the ionization saturation currents. This enhancement may be employed for measurements of low dose rates, such as background radiation, or for small cavity, probe-type chambers used to explore dose distributions in phantoms or close to small radiation sources. The design, operating characteristics, and usefulness of a cylindrical multiplication chamber and a small spherical multiplication chamber are described. Finally, studies to be made with monoenergetic neutrons to evaluate the requirement for tissue equivalent gas in the cavity of a parallel plate chamber are projected. Studies are planned to investigate the relation between chamber design and useful neutron energy range. The use of air, or some other non-tissue equivalent gas, even one more suitable for obtaining multiplication, could result in very useful simplifications of the design and use of tissue equivalent ionization chambers. (auth)

6692 (CONF-691106–, pp 30-45) RECENT PROGRESS IN NEUTRON SOLID-STATE DOSIMETRY. Becker, Klaus (Oak Ridge National Lab., Tenn.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Both radiophotoluminescence (RPL) and thermoluminescence (TL) detectors can be made very sensitive to thermal neutrons. Typical examples are newly developed glass dosimeters with very small photon energy dependence based on the (Li_2O, B_2O_3, BeO) system, which are activated with Ag for RPL and with Mn for TL dosimetry. Because of the low inherent fast neutron sensitivity of all TL and RPL detectors, fast neutrons can best be detected after thermalization; different methods for doing this are discussed briefly. Some qualitative changes in the detector response as a function of LET are described. Detectors based on thermally stimulated exoelectron emission (TSEE) can be made directly sensitive to fast neutrons by combination with a hydrogenous recoil proton radiator. Because of the extremely thin sensitive layer of very sensitive new ceramic BeO detectors, fast neutron doses of <1 mrad can be measured with little energy dependence, at least in the 0.1 to 16 MeV neutron energy range. Some dosimetric properties of TSEE detectors are summarized. Thermal and fast neutron dosimetry by nuclear track etching in polymer foils via fission reactions was simplified greatly by a new jumping spark automatic counting technique that was also used for ultrasensitive measurements of quantity and distribution of fissile materials and alpha emitters in biological samples and water. The neutron energy dependence of registration of recoil nuclei in foils was measured. Environmental effects of foil sensitivity, such as an interesting oxygen effect, are mentioned. (auth)

6693 (CONF-691106–, pp 73-94) REVIEW OF DEPTH-DOSE CALCULATION AND EXPERIMENTATION. Auxier, J. A.; Jones, T. D.; Hubbell, H. H. Jr. (Oak Ridge National Lab., Tenn.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

The absorbed dose distribution in biological material as a function of position in the material is assumed to be important in the interpretation of biological responses to radiation environments; Yet few experimenters have sufficient data to attempt a correlation of a dose distribution function with biological response. The objective of this review is to ascertain the status of capabilities of measurement and calculation of absorbed doses from neutrons incident on large animals. Calculations made by various groups throughout the world are made usually without adequate consideration of the needs of experimenters, and experimenters do not usually attempt measurements such that their data could be compared readily with calculated values. However, comparisons are made to the extent possible; data generated at ORNL are extended, where necessary, to compare with data from both experimental and calculational studies. With modern technology, measurements of absorbed dose as a function of depth for most radiations can be accomplished with adequate accuracy. Large computers provide a means of calculating complex distributions, the simpler ones of which can be checked experimentally, thus giving added confidence to the more complex of the calculations. The measurements and calculations agree quite well generally. Therefore, biological correlations should be possible. Computers capable of handling dose functions for correlations with biological data are commonplace. (auth)

6694 (CONF-691106–, pp 95-115) CURRENT RESEARCH IN DEPTH DOSE CALCULATIONS. Frigerio, Norman A. (Argonne National Lab., Ill.); Branson, Michael H. (Rhode Island Univ., [Kingston]).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

A complete-analog Monte Carlo program BIm 130 is described for the detailed computation of neutron/photon interactions with matter to at least 15 MeV. Versions are available for the CDC-3600 and IBM-360/75 systems, with speeds up to 10^4 interactions per minute. Twenty-four regions, of any composition chosen from 15 elements, may be specified. These may be of any size, in any relation including containment, and of any shapes expressible as algebraic functions. Any number and type of sources may be specified, of any sizes and shapes, internal or external, and of any energy and angular distributions expressible functionally or tabularly. The program utilizes available cross sections for neutron capture and differential scatter (elastic, inelastic, and non-elastic, given as $f(E,\theta)$) along with chemical binding functions for low energies. Photoelectric, Compton, and pair-production cross sections are used for γ. Tape output is utilized to store complete vector-position descriptions of each interaction for later review. Prompt output provides 128-channel neutron, photon and LET spectra out of, into, through and/or within all regions as well as n/γ dose spectra for each region, and doses deposited in over 60,000 n and γ histograms. Applications to a number of depth dose situations are illustrated by comparisons of program output with analytical computations (agreement to 0.3% or better), and with a number of simple and complex experiments. These include: large spheres of glass and liquid near a cylindrical gamma source within a concrete room; Fe SO_4 dosimeters in a water-Pb-steel ^{60}Co irradiation facility; human phantoms exposed to reactor neutrons in a concrete and steel room; human head phantoms exposed to monoenergetic and reactor neutrons, from anisotropic sources, of energies to 1.5 MeV; human phantoms containing ^{252}Cf sources; human phantoms exposed to 3 and 14 MeV neutrons as emitted from a scattering, moderating collimator; dose and spectra distributions in space, and in mouse phantoms, at the JANUS fission-neutron facility. In each case, agreement of n, γ, LET, and/or dose values and spectra were well within experimental error. Computed depth dose, n, γ and LET spectra are also presented for multi-region human and apeutic and radiobiological interest. Problems inherent in the use of congruential random number generators are discussed, and the method used to avoid these problems is described, as well as methods being used to generate sets of truly random bits for future use. (auth)

6695 (CONF-691106–, pp 116-28) $LD_{50(30)}$ AND DOSE DISTRIBUTION STUDIES IN SWINE IRRADIATED WITH FISSION NEUTRONS, 14 MeV NEUTRONS, AND ^{60}Co GAMMA RAYS. Wade, Leo Jr.; Brown, D. G. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Swine were irradiated with ^{60}Co γ rays, unmoderated fission neutrons, or 14 MeV neutrons. The $LD_{5(30)}$ (tissue dose in air) was 420 rad for ^{60}Co γ radiation, 820 rad for mixed neutron-gamma radiation and 498 rad for 14 MeV neutrons. Depth dose distributions were calculated for swine exposed to 14 MeV neutrons or a mixed neutron gamma field. The depth dose distribution for ^{60}Co γ irradiation was obtained by measurements with radiophotoluminescent glass rod dosimeters. An RBE of approximately 0.5 was calculated for both fission neutrons and 14 MeV neutrons. (auth)

6696 (CONF-691106–, pp 129-39) LINEAR ENERGY TRANSFER AND MICRODOSIMETRY. Rossi, Harald H. (Columbia Univ., New York).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

The biological effectiveness of neutrons depends on their energy. A mere statement of the absorbed doses involved is therefore an insufficient characterization of physical irradiation conditions in both radiobiology and radiation protection. The simplest specification is given by the spectrum of neutron energies at the locations of interest. However this is often difficult to determine. An additional and more fundamental difficulty is that knowledge of the neutron spectrum does not confer explicit information on the physical characteristics of the charged particles that deliver the absorbed dose. This information is essential for all attempts to understand the biophysical processes involved. Data suitable for this purpose can be furnished utilizing various distributions in which the independent variables are LET or the quantities of microdosimetry. It will be shown that LET has only limited usefulness and that its various distributions have in fact no physical reality. Microdosimetric quantities determined using wall-less proportional counters can, at least in principle, give an arbitrarily detailed description of irradiation conditions as far as physical characteristics are concerned. However the pertinent distributions must be given in terms of one or more parameters resulting in a complex body of information. (auth)

6697 (GAT–628) ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS, FIRST HALF 1970. Kalmon, B.; Hulett, S. H. (Goodyear Atomic Corp., Piketon, Ohio). 14 Sep 1970. Contract AT(33-2)-1. 10p. Dep. CFSTI.

The average environmental radiation levels for the Goodyear Atomic Corporation gaseous diffusion plant, for the first half of 1970, are summarized. The results for the first and second half of the calendar year 1969 are also included in tabulated form in this report. For the first half of 1970, the water α and $\beta-\gamma$, and the air α radioactivity decreased when compared with the 1969 calendar year values. For the first half of 1970, the air $\beta-\gamma$ radioactivity increased when compared with the 1969 calendar year values. Penetrating background dose rates for the first half of 1970 remained essentially the same when compared with the 1969 calendar year values. Only the results of air samples taken from a minimum of four off-site sampling locations at a frequency of at least three, 1000 ft^3 samples per week are reported. In selecting sample locations, the prevailing wind direction and the locations with the highest concentrations were considered as indicated in past reports. (E.R.B.)

6698 (INR-1185) RADIOACTIVE CONTAMINATIONS ON SITE AND IN THE ENVIRONS OF THE INSTITUTE OF NUCLEAR RESEARCH AT SWIERK IN THE PERIOD 1958-1967. Cwik, T.; Gorberg, Z.; Kostyrko, A.; Zarnowiecki, K. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 42p. (In Polish). Dep. NTIS (U. S. Sales Only).

The program and methods of measurements of radioactivity in samples collected for investigations from the site and environs of the Swierk Centre of the Institute of Nuclear Research are presented. The results of investigations of radioactivity in air, related to the nuclear tests, in wastes released from the Swierk Centre, and in waters, plants, and soil collected from the site and environs of the Swierk Centre during the period 1958 to 1968 are presented and discussed. (auth)

6699 (JINR-E16-5384) EXPERIMENTAL DETERMINATION OF QUALITY FACTOR FOR 200 MeV PROTONS BY A SET OF IONIZATION AND SCINTILLATION DETECTORS. Pszona, S.; Zielczynski, M.; Komochkov, M. M.; Sychev, B. S.; Cherevatenko, A. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 11p. Dep. NTIS (U. S. Sales Only).

An experimental arrangement consisting of an ionization chamber and a scintillation detector for measuring the quality factor, or depth dose distribution, of high-energy protons is described. The distribution of the quality factor (QF) in a tissue equivalent slab phantom irradiated with 200 MeV proton beam was estimated. (auth)

6700 (KY-624) ENVIRONMENTAL MONITORING SUMMARY FOR THE PADUCAH PLANT FOR 1969. Davis, K. A. (Paducah Gaseous Diffusion Plant, Ky.). 2 Nov 1970. 10p. Dep. NTIS.

Data from the outdoor monitoring of air, water, and vegetation in the vicinity of the Paducah Gaseous Diffusion Plant, Ky., is summarized for the year of 1969. (auth)

6701 (SC-RR-70-338) COMPUTATIONAL METHOD FOR CALCULATION OF RADIOLOGICAL DOSE RESULTING FROM HYPOTHETICAL FISSION PRODUCT RELEASE. Bonzon, Lloyd L.; Rivard, Joseph B. (Sandia Labs., Albuquerque, N. Mex.). Jul 1970. 150p. Dep. CFSTI.

An improved method for the calculation of radiological doses resulting from the release of fission products to the environment following a reactor excursion is presented, including the derivation of, and the limitations on, the inhalation dose equation. The method is applied in the linked computer codes FISSP and CLOUD to the calculation of external and internal doses resulting from the hypothetical release and dispersal of 326 fission product nuclides and metastable states. The sensitivity of the results to parameter variation is reported, including a study of the influence of unlisted MPC values upon the inhalation doses. (auth)

6702 (UCD-472-117, pp 52-4) THERMOLUMINESCENT DOSIMETRY IN ^{90}Sr-LABELED BEAGLE BONES: A PRELIMINARY REPORT. Momeni, M. H.; Della Rosa, R. J.; Goldman, Marvin; Stone, J. M. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Preliminary results are given for β-radiation activity values in samples of humeral and vertebral bone from one D5-level dog. Comparative measurements were obtained by TLD and radiochemical analyses. (auth)

6703 RECENT RESULTS OF MONTE CARLO DOSE CALCULATIONS APPLICABLE TO METABOLIZED ISOTOPES. Ellett, W. H. (Royal Postgraduate Medical School, London); Brownell, G. L. Strahlentherapie, Sonderbaende; 67: 382-5(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

The equations for calculating γ dose using absorbed fractions and specific absorbed fractions are reviewed. Use of these equations and the appropriate Monte Carlo data allows the dose from scattered γ-rays to be considered rigorously in the dose calculation. Point source functions for 80 and 140 keV photon emitters are presented and the results compared to dose calculations based on an assumed exponential absorption of γ energy. It is shown that for these photon energies, the absorbed dose may be underestimated by a factor of two using an exponential approximation. (auth)

6704 ABSORBED DOSE AND DOSE EQUIVALENT FROM NEUTRONS IN THE ENERGY RANGE 60 TO 3000 MeV AND PROTONS IN THE ENERGY RANGE 400 TO 3000 MeV. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.); Armstrong, T. W.; Coleman, W. A. Nucl. Sci. Eng.; 42: 367-81(Dec 1970).

Nucleon-meson cascade calculations have been carried out for monoenergetic neutrons (60 to 3000 MeV) and protons (400 to 3000 MeV) normally incident on a semi-infinite slab of tissue 30 cm thick, and the absorbed dose and dose equivalent as a function of depth in the tissue are presented. The calculated absorbed doses from 180- and 525-MeV incident neutrons and 660- and 730-MeV protons are compared with experimental data. For 525-MeV incident neutrons, the experimental and calculated absorbed doses are in good agreement, but this is not the case with the other comparisons. (auth)

6705 TRANSMISSION UND ABSORPTION. EIN ALLGEMEINES GESETZ FUER IONISIERENDE STRAHLUNGEN. (Transmission and Absorption. A General Rule for Ionizing Radiation). Melcher, H. Berlin; Veb Deutscher Verlag der Wissenschaften (1970). 206p. 25,- M.

Mainly from a theoretical standpoint, physical data and mathematical treatment are considered with respect to electron beams, x-emitters, and β-emitters. All three aspects of the interaction with material (transmission, absorption, and backscattering) are considered for homogenous as well as inhomogenous beams. Treatment is restricted to partial flux. In addition, comprehensive formulas are developed for other particle beams such as mesons and fission products. Applicability of the theoretical considerations is demonstrated by depth dose curves for medical purposes. (H.B.G.)

6706 ON THE beta-RAY DOSE AT THE INTERFACE BETWEEN TWO MEDIA. O'Brien, K. (Atomic Energy Commission, Washington, D. C.). Health Phys.; 19: 451 (Sep 1970).

It is pointed out that solutions to the problem of obtaining β-ray doses when the radiation source lies on the boundary between two media have been obtained by Roesch (HW-3212, 1969) and O'Brien et al (NSA 18: 11239). A table of the dose rates calculated and measured in an infinitesimal air gap on the interface between a lower half-space of natural uranium and an upper half-space of varied material is given and briefly discussed. (UK)

6707 RADIOLOGICAL DOSE COMPUTATION. Beattie, Jack R.; Bryant, Pamela M. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Safety; 11: 490-1(Nov-Dec 1970).

The results of radiological dose computations based on a hypothetical reactor fission product release are presented in graphic form. The computations include: radioactive inventory (expressed in Ci) at 300 days post release; thyroid inhalation dose following reactor release at ground level; cloud γ dose following reactor release at ground level; and cloud γ dose for a 24 hr reactor release by 1% leakage per day at ground level. The computations were compared (on the graphs) with data previously published in Nuclear Safety (Van der Hoven and Gammill, Nucl. Safety, 10(6): 513-521, Nov- Dec, 1969). (E.R.B.)

Radiation Protection

Refer also to abstract 6514.

Safety Procedures

Refer also to abstracts 6808 and 8089.

6708 AVOIDANCE OF POLLUTION IN THE DISPOSAL OF RADIOACTIVE WASTES. Dunster, H. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Atom (London); No. 162, 65-70(Apr 1970).

It is stated that the disposal of radioactive wastes in the last 25 years has been carried out without causing pollution, but with the world nuclear generating capacity increasing it is essential that the successful control of radioactive waste is maintained. Radiation dose limits and estimated risks are discussed. The merits and demerits in the British and American methods of

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keeping public exposure to all pollution to a minimum are examined. Reactor licensing in both countries is reviewed. It is urged that solutions which avoid extremes of uncontrolled pollution on one hand and a major cut back in our rate of technological advance on the other are sought. (UK)

Legal Aspects

6709 PRIMARY CARCINOMA OF THE LIVER IN HIROSHIMA AND NAGASAKI, JAPAN. Schreiber, William M.; Kato, Hiroo; Robertson, James D. (Atomic Bomb Casualty Commission, Hiroshima. Atomic Bomb Casualty Commission, Nagasaki). Cancer; 26: 69-75(Jul 1970).

The prevalence rate of primary carcinoma of the liver was 2.6% in Nagasaki, Japan and 0.9% in Hiroshima. No relationship between primary carcinoma of the liver and ionizing radiation was demonstrated. Posthepatic cirrhosis was the type of cirrhosis most commonly found in association with a hepatoma. The threefold difference between these cities in the prevalence rate of carcinoma of the liver is in part explained by the greater tendency of cirrhosis in Nagasaki to be associated with a hepatoma. (auth)

Medicine

Refer also to abstracts 6259, 6267–6271, 6276–6279, 6286, 6343, 6384, 6385, 6387, 6388, and 6412.

Protective Substances

Refer also to abstracts 6674, 6763, and 6810.

6710 (EUR-4492) BIOLOGICAL INDICATORS AND FIRST LESIONS AFTER IRRADIATION. Annual Report, 1968. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 28 Apr 1969. 24p. Dep. NTIS (U. S. Sales Only). EUR FF 4.45.

Studies on the effects of mixtures of radioprotective compounds on x-irradiated mice resulted in an increase in short- and long-term survival and reduction of incidence of cancers and leukemia. The metabolism of deoxycytidine and nicotinic acid was studied in x-irradiated and unirradiated animals. Effects of x radiation on spermatogonia, spermatocytes, and spermatozoa of mice were investigated. Inhibitory effects of AET and MEA on DNA synthesis in various organs of rats were studied. Studies were conducted on the fate of bacterial DNA in Arabidopsis and other higher organisms. (auth)

6711 (UCRL-20110) IN VIVO STUDIES OF RADIATION POTENTIATON BY IODOACETAMIDE AND OBSERVATIONS ON TUMOR TRANSPLANTATION IMMUNITY. Richards, W. Robert; Kelly, Lola S. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct 1970. Contract W-7405-eng-48. 114p. Dep. NTIS.

Thesis. Submitted by W. Robert Richards.

Iodoacetamide has been shown to be a radiation sensitizer for bacteria and for certain mammalian cells tested in vitro. The effect of iodoacetamide on the x-radiosensitivity of ascites tumor cells was studied. Survival of ascites tumor cells maintained in the peritoneal cavity of mice was used as an indicator of sensitization. Survival was assessed using TD_{50} and total tumor cell population determination methods. A comparison of results obtained by these methods is made. The effects of oxygen tension and radiation dose rate upon results were examined. Iodoacetamide was found to be effective as a radiation sensitizer under all conditions although to a lesser degree than that reported by others for in vitro experiments with bacteria. Radioactive tracer studies indicate that iodoacetamide has rapid and total access to most if not all tissues of the body. This fact coupled with the observation of a sensitization in an in vivo system where the anoxia so prevalent in well developed tumors was present, suggests the possibility of clinical usefulness of iodoacetamide in cancer radiation therapy. (103 references) (auth)

6712 CYSTEAMINE, CYSTAMINE, AND SINGLE-STRAND BREAKS OF DNA IN CULTURED MAMMALIAN CELLS. Sawada, S.; Okada, S. (Univ. of Rochester, N. Y.). Contracts AT(30-1)-1286; W-7401-Eng-49. Radiat. Res.; 44: 116-32(Oct 1970).

The toxicity, protective action against radiation injury and inhibition of DNA synthesis, and rejoining process by cysteamine and cystamine were studied in cultured mammalian cells with the following results. Cysteamine toxicity: Although cysteamine in high concentrations is nontoxic, it is toxic in relatively low concentrations (0.5 mM). In low concentrations, it induces single-strand breaks of DNA in the x-irradiated and nonirradiated cells, depresses DNA synthesis in nonirradiated cells, and depresses the rate of rejoining of radiation-induced single-strand breaks of DNA in irradiated cells. Protection against radiation damage: Cysteamine (over 5 mM) protects DNA molecules from radiation-induced single-strand breaks and double-strand cuts. The degree of protection by cysteamine increases with increasing cysteamine concentrations. Inhibition of DNA synthesis and rejoining process: Cysteamine in high concentrations (over 5 mM) inhibits normal DNA synthesis of the nonirradiated cells and slows the rejoining of radioinduced single-strand breaks in irradiated cells. Cystamine shows no toxic effect and affords little protection for DNA molecules from radiation-induced single-strand breaks. However, cystamine inhibits DNA synthesis of nonirradiated cells and the rejoining process of irradiated cells. (auth)

6713 INVESTIGATION ON RADIATION PROTECTIVE PROPERTIES OF MICROBIAL ANTIGENS AND POLYSACCHARIDES. Semenov, L. F.; Stasilevich, Z. K.; Ermoleva, Z. V. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Antibiotiki; 13: 272-4(1968). (In Russian).

The following substances were administered subcutaneously to mice 24 hr prior to lethal irradiation in 0.3 to 0.5 ml individual doses: 50 mg/Kg of acetoxan, 5 mg/Kg of prodigiosan, 50 mg/Kg of lysozyme, and 1 billion units of typhoid bacilli vaccine. The following antibiotics were tested in single doses in mice: chlortetracycline 150 mg/Kg; streptomycin 2000 units; penicillin 20,000 units; and 175 mg/Kg of cystamine (5 min prior to irradiation). The experiments included 1980 mice (wt. 18 to 22 g), that received whole-body irradiation with ^{60}Co γ rays in a single dose of 950 R or 1050 R at 60 to 75 R/min. The mice treated with individual doses of typhoid vaccine, acetoxan, prodigiosan, and the 950 R irradiation dose demonstrated a 20 to 30% survival rate up to 30 days, while the 1050 R dose produced the same response in 11 to 21% of the mice. Under identical conditions, lysozyme had little effect (6 to 9%) and antibiotics still less (0 to 1.5%), while cystamine increased the 30-day survival rate by 33 to 62% following 950 R and 1050 R irradiation doses. When polysaccharides or microbial antigens were combined with cystamine, the effectiveness of the radioprotectors increased. (BBB)

6714 EFFECTS OF MUMIE ON SERUM PROTEIN CONTENT AND PROTEIN FRACTIONS OF BLOOD IN ACUTE RADIATION SICKNESS. Pauk, S. I.; Tukhtaev, T. M. (Tadzhik State Univ., Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR, 12: No. 6, 64-7(1969). (In Russian).

Effects of mumie on biochemical indices in blood of healthy and irradiated animals were studied using 285 rats weighing 150 to 170 g and treated perorally with 500 $\mu/_{kg}$ of mumie from the third day up to the 25th day following x irradiation at 2R/min to a total dose of 450 R. The experiments indicated early variations in peripheral blood and hemopoietic organs. An increased content of reticular cells in the marrow and spleen was noticed on the third day and still further changes on the seventh day (during acute radiation sickness). On the 12th day, a slow restoration to normal amounts of albumen was observed in all animals but a much more rapid increase of albumen was observed in those treated with mumie. On the 20th day the amount of albumen increased in all animals, however, the initial amount of albumen was restored only in animals previously treated with mumie. The influence of mumie on the serum albumen was related to normalized liver functions and inhibited hemorrhagic syndrome. (R.V.J.)

Radiation Sickness and Injuries

6715 RADIATION EFFECTS ON THE FACE AND ORAL CAVITY. Rapp, H.-J.; Schubert, H. (Humboldt-Univ., Berlin). Deut. Stomatol.; 20: 357-62(May 1970). (In German).

Every patient who has been subjected to irradiation for a cancer of the cheek, the mouth or the neck presents typical alterations that must be known to the stomatologist. If such a patient seeks treatment from a dental practitioner for tooth or jaw pain, the latter must send him immediately, because of the risk involved, to the physician who treated the patient first, since competent treatment can be instituted only by the oral surgeon or the radiologist. If the stomatologist intervenes himself, from ignorance or for other reasons, his action could be considered (in the light of present knowledge) as near malpractice. (auth)

Radiodiagnosis

Refer also to abstracts 6531, 6631, and 6632.

6716 (ACRH-1000-204) TUMOR LOCALIZATION WITH THE GAMMA CAMERA. Gottschalk, Alexander (Argonne Cancer Research Hospital, Chicago, Ill.). [1969]. 13p. (CONF-700507-4). Dep. CFSTI.

From 10th International Cancer Congress, Houston, Tex.

Enhancement of tumor detection in selected organ systems by means of the γ scintillation camera is described. Nuclide angiograms for diagnosis of brain tumors reveal neoplasms not seen during routine brain scans. The technique is particularly helpful in the diagnosis of cerebrovascular accidents, arteriovenous malformations, and meningiomas. Transmission scintiphotography utilizes the image formed when a large uniform source of activity is transmitted through the patient. Using ^{99m}Tc it is possible to obtain a transmission scan of the heart and lungs in one-half minute or less with a dose to the patient of approximately 10 millirads. Recent advances in liver scintiphotography using ^{99m}Tc sulfur colloid are discussed; advantages of this technique for diagnosis of liver diseases such as fibrosis, edema, cirrhosis, and biliary dilatation are discussed The use of ^{75}Se-selenomethionine in pancreas scanning with the gamma camera is discussed; although it was not possible to distinguish between carcinoma and pancreatitis, some valuable results were obtained. (H.L.W.)

6717 (BRH/DEP-70-27) STUDY OF HEAD AND NECK EXPOSURE FROM POLYTOMOGRAPHY. Cassady, J. Robert; Pierce, Robert N. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Nov 1970. 13p. NTIS.

An investigation was conducted to determine radiation exposures to the head and neck regions of patients undergoing polytomographic studies of the sella turcica, paranasal sinuses, and petrous pyramid. The highest exposures were measured at the eyelid region for studies of the sella turcica and paranasal sinuses. In studies of the petrous pyramid, the highest exposures were recorded in the external auditory canals. Variation in the total number of exposures, the ratio of frontal and lateral exposures, and beam collimation are cited as principal causes of the wide range of values recorded for a given dosimeter location and type of examination. To reduce eye exposures, it is recommended that PA rather than AP projections be used for tomography of the petrous pyramid, sella turcica, sphenoid sinus, and other mid- and posteriorly located structures of the skull. (auth)

6718 (DP-1231) FAST NEUTRON RADIOGRAPHY FOR CLINICAL DIAGNOSIS. Parks, P. B.; Brown, M. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sep 1970. Contract AT(07-2)-1. 26p. Dep. NTIS.

Fast neutron radiography was found to be impractical for medical diagnosis. Calculations showed that this type of radiography could be accomplished at acceptable radiation dose levels, but with practical sources and known detector systems, the calculated exposure times would be longer than acceptable to practicing radiologists. Only ^{252}Cf and small ^{3}H(d,n) accelerators were considered to be potentially useful sources for fast neutron radiography. Calculations showed that fat, muscle, and bone would have relatively little contrast against each other, but suggested that air pocket imaging might be useful, such as in lung radiography. Proposed broad beam and transmission scanning imaging systems were evaluated in terms of γ-ray and scattered neutron interference, and the clinical constraints of dose and exposure time. Known broad beam detection schemes that could minimize γ interference from ^{252}Cf sources were too inefficient for the rapid imaging required in clinical situations. Moreover, scattered neutron interference could not be removed. Transmission scanning, which could minimize γ-ray and scattered neutron backgrounds, was even slower and hence unacceptable. Only ^{3}H(d,n) broad beam radiography can be accomplished in exposure times within an order of magnitude of clinically acceptable limits. However, ^{3}H(d,n) radiography was judged to have no advantage over existing roentgenographic techniques. (auth)

6719 (UCD-472-117, pp 87-8) RADIONUCLIDE MARKING OF CANINE FETUSES FOR STUDYING ONTOGENY OF THE IMMUNE RESPONSE. Stone, J. M.; Shifrine, Moshe (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

The radionuclides ^{51}Cr, ^{54}Mn, ^{57}Co, ^{59}Fe, and ^{65}Zn were used at a concentration of 0.1 μCi to mark fetuses in utero. After cesarian delivery or at birth the fetuses were identified by the energy spectra of their radionuclide markers. The use of radionuclide markers in studies of fetal immunology presents obvious advantages in methodology and economy. (auth)

6720 APPLICATION OF LIVER SCAN TO THE DIAGNOSIS OF ESOPHAGEAL VARICES. Rogers, Arvey I.; Feiss, Joel S. (Univ. of Miami, Fla. Veterans Administration Hospital, Miami, Fla.). S. Med. J.; 63: 950-3(Aug 1970).

A high correlation was found between the presence of esophageal varices and the degree of uptake of radioactive gold by the liver and the extrahepatic reticuloendothelial system. This suggests a possible diagnostic value of liver scan in portal hypertension. (auth)

6721 RADIOAKTIVE ISOTOPE IN KLINIK UND FORSCHUNG. BAND VIII. VORTRAEGE AM GASTEINER INTERNATIONALEN SYMPOSION, BAD GASTEIN, AUSTRIA, JANUARY 9-12, 1968. (Radioactive Isotopes in Clinics and Research. Contributions to the Gastein International Symposium, Bad Gastein, Austria, January 9-12, 1968). Fellinger, K.; Hoefer, R. (eds.). Sonderbaende zur Schwarzenberg (1968). 522p. DM 99.60. (In several languages). (CONF-680119).

Separate abstracts were prepared for 37 of the 56 papers in this conference. The other 19 papers were not within the scope of NSA. These papers discussed routine trace techniques in medicine and research. (E.R.B.)

For abstracts of individual papers see: 6722-6741, 6282, 6283, 6599-6604, 6624-6631, and 6703.

6722 QUANTITATIVE DISTRIBUTION OF SEVERAL RADIOISOTOPES AMONG VARIOUS ORGANS BY MEANS OF A TEN-CRYSTAL SCANNER AND COMPUTER-SCINTIGRAPHY. Hundeshagen, H. (Medizinische Hochschule, Hanover). Strahlentherapie, Sonderbaende; 67: 1-10(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

A ten crystal scanner is described together with a 4096 channel memory and a computing unit. The information obtained with the scanner is fed into a computer. Maximal information to be obtained per scan amounts to 40,000 words. Multitracer studies were carried out using this unit. As an example a liver radiogoldscan is substracted from a liver-pancreas-seleno-methionine scintigram to visualize the pancreas alone. It is further possible to compare passage-patterns of a radioactive tracer at different sides of an organ. Liver clearance curves after application of radioiodine labeled rose bengal and colloidal radiogold may directly be compared with each other. (auth)

6723 USE OF A 1600 CHANNEL ANALYZER WITH A GAMMA SCINTILLATION CAMERA IN THE QUANTITATIVE ASSESSMENT OF ORGAN FUNCTION AND SIZE. Polcyn, R. E.; Paloyan, D.; Hendricks, K. O.; Gottschalk, A.; Harper, P. V. (Univ. of Chicago. Argonne Cancer Research Hospital, Chicago). Strahlentherapie, Sonderbaende; 67: 11-22(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Our 1600 channel analyser provides rapid analog and digital readout from its memory. The memory can be programmed to store and dump serially with good accuracy. Using each memory channel to represent a definite area (0.7 cm^2) of the gamma camera crystal, a number of quantitative studies were undertaken. Relative renal function and size can be assessed from a delayed (24 or 48 hr) renal scan with both ^{99m}Tc-iron complex and ^{203}Hg-neohydrin. The technique is less cumbersome and more accurate than other methods. Right and left cranial blood flow is being studied with 0.6 sec storage and print-out cycles as an injected bolus of ^{99m}Tc makes its first pass through the head. Distinctive patterns were found in patients with vascular insufficiency, shunt, and vascular neoplasm. Trapping of pertechnetate ion by the thyroid gland proceeds rapidly and appears potentially to represent a useful parameter in the study of thyroid function. The camera analyser combination was used in a new technique for obtaining the thyroid uptake of pertechnetate at serial 1 min intervals immediately following intravenous injection of the agent in euthyroid, hypothyroid, and hyperthyroid patients. Methods, results, and limitations are discussed. (auth)

6724 QUANTITATIVE INVESTIGATIONS OF THE DISTRIBUTION OF RADIOISOTOPES IN VARIOUS ORGANS WITH A DIGITAL AUTOFLUOROSCOPE. Schmidlin, P.; Kampmann, H.; Lorenz, W. J.; Maier-Borst, W.; Krauss, O.; Adam, W. E.; Scheer, K. E. (Deutsche Krebforschungzentrum, Heidelberg). Strahlentherapie, Sonderbaende; 67: 23-32(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Comparative studies were carried out, using the ANGER-Camera and the BENDER-BLAU digital autofluoroscope. Sensitivity and spacial resolution of the two systems was measured. It was found that there is little difference between sensitivity and inherent resolution of these two cameras. Resolution as influenced by collimation, assuming equal sensitivity, is the same for both systems for γ ray energies between 100 and 400 keV. For energies above 500 keV the BENDER-BLAU autofluoroscope gives better results as could be shown in animal experiments with ^{131}I-Hippuran, ^{131}I-Rose-Bengal, ^{68}Ga-EDTA, ^{64}Cu-Acetate, ^{99m}Tc-Macroalbumin, ^{18}F and ^{198}Au colloid. (auth)

6725 SOME PROBLEMS IN THE ESTIMATION OF LOCALIZED ACTIVITY. Eversden, I. D.; French, Rosemary J.;

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Trott, N. G. (Inst. of Cancer Research, Sutton, Eng. Royal Marsden Hospital, Sutton, Eng.). Strahlentherapie, Sonderbaende; 67: 33-45(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

In assessing the radiation dose resulting from the administration of radioactive materials, it is often necessary to determine the activity localized at particular sites in the body. Such determinations have other applications including physical assessments of the performance of scanning and camera systems in various clinical investigations. The performance of particular types of detectors used in localized measurements is described. Studies of the effects of scattering by the collimator, and within the medium containing the radioactive source are reported. Particular attention is given to the use of a conical type of collimator originally developed for ^{131}I uptake measurements and to the performance of a 127-hole focusing collimator. Possible advantages of such a focusing collimator in measurements of localized sources are discussed. An account is given of some of the difficulties that arise in practice, particularly in the estimation of dose to the lungs and the lymph nodes during treatment with ^{131}I-Lipiodol. Reference is also made to application of these techniques in estimating dose in tracer investigations. (auth)

6726 METHOD FOR CORRECTING FOR DISTORTIONS DUE TO RESOLUTION IN SCINTIGRAPHIC STUDIES. Di Paola, R. (Institut Gustave-Roussy, Villejuif, France); Albarede, P.; Tubiana, M. Strahlentherapie, Sonderbaende; 67: 46-61(1968). (In French).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

If the sensitivity of a collimated detector is high enough to allow clinical scintigraphic studies, resolution power of the detector is limited; distortion of the scintigraphic picture obtained and attenuation of contrast is caused. Reconstruction of the original information from an image distribution with the help of the response function of the detector system used is a general problem and was tried in various fields. A method is described for information reconstruction in cases of linear and surface distribution that may be used in quantitative scintigraphy. For special distribution an iterative technique is used. The influence of statistical fluctuations will be discussed. A computer (Univac 1108) is necessary for this method of correction of distortion due to the limited resolving power. This method should also be useful for modifying the antagonistic relation between resolution and sensitivity in quantitative scintigraphy. (auth)

6727 DIFFERENTIAL ISOTOPE SCANNING OF THE BRAIN EMPLOYING AN ELECTRONIC RATIO-SUBTRACT TECHNIQUE. Field, E. O.; Cottrall, M. F.; Burn, G. P.; McCready, V. R. (Inst. of Cancer Research, Sutton, Eng. Radcliffe Infirmary, Oxford). Strahlentherapie, Sonderbaende; 67: 62-8(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Selective localization of isotope labeled material in tissues or organs may be masked by high background radioactivity in the blood or in neighboring structures. By employing a second, marker, isotope, with which the background radioactivity is monitored, it is possible to reject the background activity and to obtain scintiscans showing exclusively the areas of selective uptake. We have designed an electronic system which can be incorporated into any conventional clinical scintillation scanner, and with this device have studied the localisation of different radiopharmaceuticals in brain tumors. Using ^{132}I-labeled human serum albumin to monitor the blood we have demonstrated that ^{99m}Tc-pertechnetate is very rapidly secreted into the nasopharynx and nasal sinuses, which accounts for the high activity recorded from the facial region in conventional scans with the latter isotope. In contrast, by using ^{99m}Tc-labeled human serum albumin to monitor the blood, it was possible to eliminate activity due to ^{197}Hg-neohydrin from the base of the skull and the region of the sella turcica. The device was also used to obtain scans of the pancreas with ^{75}Se-selenomethionine, by monitoring activity in the liver with ^{198}Au-colloid. (auth)

6728 STUDIES ON INTRARENAL HIPPURAN KINETICS WITH AN ANGER CAMERA AND A DIGITAL COMPUTER. Winkler, C.; Knopp, R. (Univ., Bonn). Strahlentherapie, Sonderbaende; 67: 69-76(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

The conventional Radioisotope-Nephrogramm was simulated with a digital computer using a five-compartment model. It was shown that different pathophysiological conditions may result in identical curves. Increased diagnostic information can be obtained using quantitative sequential scintigraph with the scintillation camera and data processing with the computer. The method was clinically applied in cases of parenchymal renal disease, stenosis of the renal artery and renal transplants. (auth)

6729 ANALYSIS AND VALUE OF EXTERNAL MEASUREMENTS IN THE ^{198}Au CLEARANCE TECHNIQUE. Ivancevic, D.; Simonovic, I. (Medical Faculty, Zagreb). Strahlentherapie, Sonderbaende; 67: 88-99(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Gold-198 is administered intravenously as a colloid. It is assumed that the larger size particles are incorporated into the Kupffer cells of the liver, while the small particles enter the reticulo-endothelial system of the bone marrow. Under this assumption, hepatic blood flow can be estimated quite reasonably from scintillation counting of the liver region or the thigh. (H.B.G.)

6730 KINETICS OF $^{14}CO_2$ EXHALATION FOLLOWING ORAL ADMINISTRATION OF ^{14}C-LABELED FATTY ACIDS AND FATS IN MALFUNCTIONS OF THE PITUITARY, ADRENAL, AND THYROID GLANDS. Glaubitt, D.; Frahm, H. (Univ., Hamburg). Strahlentherapie, Sonderbaende; 67: 109-21(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Measurement of ^{14}C radioactivity in CO_2 of expired air after the administration of a ^{14}C labeled tracer will give information regarding its metabolic behavior. If the specific radioactivity is considered, $^{14}CO_2$ exhalation depends on a number of aspects, such as absorption and degradation in the intestinal tract. If ^{14}C-labeled fatty acids or neutral fats are given orally, a number of labeled degradation products such as CO_2 will be produced which contribute to the $^{14}CO_2$ exhalation. Seven patients with insufficiency of the pituitary after hypophysectomy, four patients with primary myxedema, and one patient with a primary insufficiency of the adrenal cortex were studied. All these patients were on substitution therapy. Furthermore, one patient with Cushing's Syndrome and six healthy controls were studied. Each received 10 μC of ^{14}C-caprylic acid, ^{14}C-trioctonat, ^{14}C-oleic acid or ^{14}C-triolein orally. The concentration of CO_2 and radioactivity in the exhaled air were measured thereafter (FHT 50 A) up to 9 hours after ingestion of the tracers. In patients with anterior pituitary insufficiency and primary adrenal cortex insufficiency on substitution therapy and in the patient with Cushing's Syndrome depression and retardation of specific radioactivity in the CO_2 of exhaled air was observed. Administration of Triiodothyronine in a patient with anterior pituitary insufficiency on substitution therapy resulted in a considerable increase of specific radioactivity. (auth)

6731 SOME INVESTIGATIONS OF ^{59}Fe ABSORPTION BY WHOLE BODY COUNTING AND EXCRETA ASSAY. Cottrall, M. F.; Stringer, Ann M.; Trott, N. G. (Inst. of Cancer Research, Sutton, Eng. Royal Marsden Hospital, Sutton, Eng.). Strahlentherapie, Sonderbaende; 67: 122-37(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Despite increasing clinical interest in the measurement of iron absorption by whole body counting, there remains some uncertainty over sources of error in this technique. Measurements were taken on 40 patients who had received oral doses of about 4 μCi ^{59}Fe. Whole-body counting, using a multiple fixed detector system in a shielded room, was carried out at intervals of about 48 hours over periods of up to 28 days, and daily excreta samples were obtained. In analyzing the whole-body spectrometer data, energy bands covering the photoelectric peak, valley and Compton continuum, including the back scatter peak, were considered. In this group of patients concerned, values obtained for absorption were in the range 3% to 90%. In general, results of whole-body counting and excreta assay were in good agreement, and reasons for those discrepancies observed are discussed. An assessment of the accuracy of the in vivo measurements is presented, with reference to experimental studies of the errors that can arise through redistribution of radioactivity in the body. The sensitivity of the counters will be considered in relation to patient size and weight, and criteria of performance examined for each of the energy bands used. (auth)

6732 ASPECTS OF IRON ABSORPTION AND IRON RETENTION, ESPECIALLY IN PATIENTS WITH IDIOPATHIC HAEMOCHROMATOSIS. Flendrig, J. A.; van Tongeren, J. H. M.;

Hogeweg, B.; Verhoef, C. W. (St. Radboud Hospital, Nijmegen, Netherlands. Radiologische Werkgroep TNO, Arnhem, Netherlands). Strahlentherapie, Sonderbaende; 67: 138-50(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Three aspects of iron absorption in idiopatic hemochromatosis were studied. Iron absorption was repeatedly determined in order to obtain an impression of the variability of the rate of absorption in individual patients. A study was made of the phenomenon of prolonged excretion of iron, i.e., the fecal iron excretion, which continues after completion of fecal excretion of a simultaneously given non-absorbable substance. A study was made of the effect of pancreatic extract on the iron absorption in patients with hemochromatosis. Iron absorption and retention were measured by means of a whole-body counter, equipped with four sodium iodide crystals. The detector arrangement and procedure were such, that in the period between oral iron administration and the first defecation, the measured extracorporeal activity varied within the 5 percent limit. The non absorbable tracer substance used in measuring the prolonged excretion was $^{51}CrCl_3$. Despite the presence of high quantities of iron in the body, patients with hemochromatosis showed no prolonged excretion. This was in contrast with patients who suffered from hemosiderosis as a result from sideroachrestic anemia. In this respect patients with hemochromatosis behaved like patients with sideropenic anemia. In contrast to some reports in the literature, we were not able to demonstrate an influence of pancreatic extracts on iron absorption in patients with idiopathic hemochromatosis. (auth)

6733 VITAMIN B_{12} ABSORPTION CORRELATED WITH THE GASTRIC SECRETION OF INTRINSIC FACTOR AS DETERMINED BY RADIOIMMUNOASSAY FOLLOWING STIMULATION WITH HISTAMINE OR PENTAGASTRIN. Irvine, W. J.; Cullen, D. R.; Scarth, Laura (Royal Infirmary, Edinburgh). Strahlentherapie, Sonderbaende; 67: 164-73(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

The intrinsic factor content was determined by radioimmunoassay in gastric juice secreted during the post histamine hour in 99 patients with achlorhydria. The method of assay was the albumin-coated charcoal technique. The presence of antibody to intrinsic factor in the serum was also measured. The results were correlated with the patient's serum vitamin B_{12} status and Schilling tests without and with exogenous intrinsic factor. The secretion of intrinsic factor of <100 nanogram units in the post histamine hour is compatible with the diagnosis of pernicious anemia while the secretion of >130 nanogram units is not compatible with this diagnosis. Intrinsic factor secretion of 80–130 nanogram units is equivocal for pernicious anemia in either its frank or latent form. Most patients with achlorhydria but normal vitamin B_{12} absorption have an intrinsic factor secretion substantially above 100 nanogram units in the post histamine hour. Out of 320 adult patients studied who were capable of secreting gastric acid the lowest level of intrinsic factor secretion in the post histamine hour recorded was 650 nanogram units. Radioimmunoassay of gastric intrinsic factor is simple to perform and should become routine when pernicious anemia is suspected. It is a particularly useful procedure in the differential diagnosis of megaloblastic anemias and in the investigation of malabsorptive diseases. The presence of antibody to intrinsic factor in gastric juice and its effect on the absorption of vitamin B_{12} is discussed. (auth)

6734 ESTIMATION OF THE REGIONAL CEREBRAL BLOOD FLOW BY THE B. A. AUTOFLUOROSCOPE. Kvist, G. (Helsinki Univ.). Strahlentherapie, Sonderbaende; 67: 386-8(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

The regional cerebral blood flow was estimated by a multicrystal detector consisting of a mosaic of 14 by 21 one square cm crystals. The radioactivity from intraarterially injected ^{133}Xe-saline was counted by the instrument and the counts transferred to a core memory from which it was recorded at six second intervals on a digital magnetic tape. From the tape the data were transferred to a digital computer and analyzed. The final results were expressed as blood flow of white and grey matter in ml/100 g/min for each viewing crystal. Routine use of the method in connection with carotid angiography is suggested. (auth)

6735 ISOTOPE TEST FOR PORTAL HYPERTENSION. Lewitus, Z. (Tel-Aviv Univ., Israel). Strahlentherapie, Sonderbaende; 67: 389-97(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

In 1957, a test of detecting liver metastasis with the help of rectally absorbed radioactive iodine was introduced by Blondheim. This test failed to give reproducible results, but as it was primarily based on conditions of pressure in the portal system we adapted it with modifications for the diagnosis of portal hypertension. A model system to test the physical basis of this method was devised. The procedure is simple, consisting of administration of a microclysma of $Na^{131}I$ and measuring simultaneously its appearance on the liver and on the precordium with a double detector-recording apparatus. The method was standardized and evaluated clinically in 66 patients with the following results: 35 patients, who served as controls and had no liver disease, showed a normal pattern in the test. Of 31 in whom there was a suspicion of liver disease, the test was abnormal in 25. In 20 of them the diagnosis was verified also by other diagnostic means. The remaining six were thought to be false positives. (auth)

6736 EXPERIMENTAL STUDIES OF THE RENOGRAM BY RENAL ARTERY CATHETERIZATION IN MAN. Baschieri, I.; Scuncio, G.; Arzano, S.; Benedetti-Valentini, F. Jr.; Citone, G. (Univ., Rome). Strahlentherapie, Sonderbaende; 67: 398-405 (1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Rapid intraarterial injection of a single tracer dose after catheterization of a renal artery allows the study of intrarenal evolution of radioactivity and registration of renographic curves. From the results, the following conclusions are drawn: the pelvis of the kidney is a cavity where successively formed portions of urine mix; drainage of radiohippuran through the ureter begins before the renographic curve has reached its maximum; the renogram can be analyzed within the first 90–120 sec of registration. (auth)

6737 ASSESSMENT OF GLOMERULAR KIDNEY FUNCTION WITH ^{131}I-INULIN, ^{131}I-DIATRIZOATE, AND ^{58}Co-EDTA. Deckart, H.; Herzmann, H. (Radiologische Klinik, Berlin. Institut fuer Angewandte Isotopenforschung, Berlin). Strahlentherapie, Sonderbaende; 67: 406-13(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Renograms were performed on 200 patients using ^{131}I-Hippuran and ^{131}I-Inulin. Corresponding and dissociating results obtained in renal diseases are discussed. The instability of ^{131}I-Inulin prompted us to use ^{131}I-diatrizoate and ^{58}Co-EDTA to study glomerular excretion. Renograms obtained with these two substances are presented. (auth)

6738 ^{75}Se-SELENOMETHIONINE UPTAKE BY MALIGNANT TUMORS. Jovanovic, D. (Cancer Inst., Louvain, Belg.). Strahlentherapie, Sonderbaende; 67: 444-8(1968).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Clearance of intravenously injected ^{75}Se-Selenomethionin and production of plasma proteins are decreased in patients with ^{75}Se concentrating tumors as compared with normal controls. On the other hand, a clear-cut time relationship exists between the blood level of radioactivity and the optimal scintigraphic localization of the tumor. These observations suggest that tumor uptake of ^{75}Se is due to phagocytosis of Selenomethionin and not of newly synthetized protein. If the radioisotope is taken up into the tumor, it remains there. Other mechanisms must, however, be considered. (auth)

6739 SCINTIGRAPHIC PORTRAYAL OF THE VASCULAR SYSTEM OF CEREBRAL ARTERIES WITH ^{131}I-LABELED MACRO-AGGREGATED ALBUMIN UNDER NORMAL AND PATHOLOGICAL CONDITIONS. Haas, J. P.; Dietz, H.; Wolf, R. (Johannes-Gutenberg-Univ., Mainz). Strahlentherapie, Sonderbaende; 67: 449-53(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Following direct intraarterial injection of macro-aggregated labeled albumin, it is possible to visualize scintigraphically the cerebrum after injection into the carotin artery and the cerebellum after injection into the vertebral artery. Interesting information about the arterial vascular system of the brain was obtained in normal subjects and very characteristic patterns in various pathologic conditions. It is felt that the method is superior to conventional techniques when diagnosing the type of brain lesion. (auth)

XUM

6740 PERFUSION SCINTIGRAPHY OF THE VASCULAR SYSTEM OF A. COELIACA AND A. MESENTERICA USING ^{131}I MAA. Bruecke, P.; Hoefer, R.; Ogris, E.; Pokieser, H. (Univ., Vienna). Strahlentherapie, Sonderbaende; 67: 461-71(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Catheterization of the celiac artery and superior mesenteriac artery, a conventional method for selective angiography of the arterial vascular system of the upper abdominal organs, was used to perform perfusion-scintigrams of these organs after injecting ^{131}I-MAA into the catheter. After obtaining a technically satisfactory perfusion-scintigram, a liverscan was performed in the usual way following iv injection of ^{198}Au-colloid. Conventional ^{198}Au liverscan and perfusion-scintigram of the liver were nearly identical in shape and size. The pancreatic region was visualized in all the perfusions-scintigrams even with non-selective catheter position. Typical normal and pathological scintigrams (pancreas carcinoma) are presented with the corresponding arteriograms. Radioactivity trapped in the capillaries of the gastric mucosa must be considered the main source of error of this method. (auth)

6741 BEHAVIOR OF ^{51}Cr-LABELED LYMPHOCYTES AFTER ADMINISTRATION OF ANTILYMPHOCYTE SERUM IN MAN. Pfisterer, H.; Meinzel, E.; Michlmayr, G.; Bolland, H.; Tsirimbas, A.; Hornung, B.; Pichlmayr, R.; Stich, W. (EURATOM, Munich. Univ., Munich). Strahlentherapie, Sonderbaende; 67: 480-5(1968). (In German).

From 8th International Symposium on Radioactive Isotopes in Clinical Medicine and Research, Bad Gastein, Austria. See CONF-680119.

Relation of total counts of lymphocytes to labeled lymphocytes was used to investigate the mechanism of lymphopenia following injection of anti-lymphocyte serum. It was found that lymphopenia occurs mainly due to a destruction of a part of the lymphocytes. The effect of an anti-lymphocyte serum depends on the titre of the serum and the initial lymphocyte count. (auth)

6742 USE OF PELVIC PNEUMOGRAPHY IN PLANNING RADIOTHERAPY OF ENDOMETRIAL CARCINOMA. Brascho, Donn J. (Univ. of Alabama, Birmingham). Radiology; 97: 113-20(Oct 1970).

Knowledge of the size, shape, and location of the uterus as obtained by pelvic pneumography can be used in planning preoperative intracavitary irradiation in cases of endometrial carcinoma. Radioactive sources may be distributed and treatment administered so that maximum tolerance of surrounding normal tissues is not exceeded in the case of a small uterus, nor is the large uterus undertreated. The dose to the uterus is expressed as an absorbed dose in rads. The author describes the technique of the examination and the development of the therapy program. (auth)

6743 TUMOR-LOCALIZING AGENTS. V. RADIOIODINATED PREGNANES. Counsell, R. E.; Hong, B. H.; Willette, R. E.; Ranade, V. V. (Univ. of Michigan, Ann Arbor). Steroids; 11: 817-26(Jun 1968).

Attempts were made to develop a radiopharmaceutical suitable for photoscanning the adrenal gland and associated tumors. As in the case of radioiodine and thyroid disease, such an agent would not only be of considerable diagnostic value but also have potential therapeutic applications. Previous studies with progesterone-4-^{14}C suggested that a radioiodinated analog might be useful for photoscanning the adrenal gland and tumors. 21-Iodoprogesterone was prepared by conversion of deoxycorticosterone to its mesylate and subsequent displacement with iodine. Depending on the conditions for mesylation, 21-chloroprogesterone could also be isolated. 21-Iodopregnenolone acetate was obtained in a similar manner from the 21-bromo analog that in turn was prepared in good yield from the enol acetate of pregnenolone acetate. The radioiodinated steroids were prepared by isotope exchange with $Na^{125}I$ in refluxing acetone. Tissue distribution studies showed that the radioactivity concentrated mainly in the thyroid gland presumably as a result of rapid in vivo deiodination. (BBB)

6744 SPLIT-DOSE RADIOTHERAPY FOR BLADDER CARCINOMA. Scanlon, Paul W.; Furlow, William L. (Mayo Clinic, Rochester, Minn.). Radiology; 97: 141-8(Oct 1970).

Data were accumulated on 94 patients with carcinoma of the bladder treated with split-dose radiotherapy from 1960 through 1966. Difficulties in accurate clinical staging were stressed, and the Jewett and American Joint Committee (AJC) methods of classification were compared. The AJC staging appeared to discriminate better between the more advanced stages of bladder tumor. The data suggest that the primary objectives of split-dose methods, reduction of radiation morbidity and improvement of ease of patient handling, have been achieved without apparent sacrifice in overall treatment effectiveness. (auth)

6745 SENSITIVITY OF BRAIN SCANNING IN THE DETECTION OF ARTERIOVENOUS MALFORMATIONS. Shishikura, A.; DeLand, F. H.; Gilday, D. (Johns Hopkins Medical Institutions, Baltimore). Radiology; 97: 95-8(Oct 1970).

Technetium-99m-pertechnetate brain scans and cerebral angiograms were correlated in 10 cases of arteriovenous malformation. Lesions 2.7 cm or more in mean diameter were detected by rectilinear scanning technique after the injection of ^{99m}Tc-pertechnetate intravenously. Limitations of detection appear to be more dependent on size than on location. (auth)

6746 RADIOMERCURY LABELED CHROMIC-β-GLYCEROPHOSPHATE: A NEW TUMOR LOCALIZING AGENT. Anghileri, J.; Reba, R. C. (Johns Hopkins Medical Institutions, Baltimore). J. Nucl. Biol. Med.; 13: 115-22(Jul-Sep 1969).

A new radiomercury labeled complex, Hg-Cr-β-glycerophosphate, is described. In mice with transplanted ependymomas this compound was found to have an average tumor-to-brain concentration ratio that is 50% higher than what has been previously found with a large number of radiochemicals. In patients with a variety of intracranial lesions, images comparable to the standard brain scanning agents were obtained. (auth)

6747 ^{113m}In FOR LIVER SCANNING. Vigneri, R.; Papalia, D.; Motta, L. (Univ., Catania, Italy). J. Biol. Nucl. Med.; 13: 106-14(Jul-Sep 1969).

The use of ^{113m}In-colloid was studied and it was pointed out that this new radiopharmaceutical is very suitable for liver scanning but its application for measuring liver blood flow is not convenient. It was concluded that the physical characteristics of the radionuclide justify its use in routine diagnostic liver scanning. (auth)

Radiotherapy

Refer also to abstracts 6473–6475, 6762, and 6804–6807.

6748 (CONF-691106–, pp 498-507) ROLE OF MODIFYING FACTORS IN NEUTRON THERAPY. Brennan, James T. (Pennsylvania Univ., Philadelphia. Dept. of Radiology).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

With respect to dose modifying and response modifying factors (dose rate, RBE, LET, depth dose, OER, etc.), there will be severe limitations on what one may elect to use in a clinical trial of fast neutrons. This is a consequence primarily of the limited capabilities of the neutron sources now available. Only four different fast neutron spectra will be used in fast neutron therapy, and only a limited range of dose rates need be considered. RBE as a function of fraction size, for early responses, is now understood for spectrum 2 (Hammersmith) but not for spectrum 4 (14 MeV). More data are needed on the RBE of fast neutrons in normal tissues as compared with the RBE in tumors. There is an urgent need to define some new terms for use in fast neutron clinical dosimetry. All fast neutron OER's measured to date were in a satisfactory range (less than 1.8). The first order isoeffect theory of Elkind for x rays seems to apply for fast neutrons in normal skin. (auth)

6749 (CONF-691106–, pp 508-19) FAST NEUTRON BEAM RADIOTHERAPY. Andrews, J. Robert (Georgetown Univ., Washington, D. C. Hospital); Swain, Robert W. (National Cancer Inst., Bethesda, Md.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Low LET (x rays or γ rays) and high LET (14 MeV fast neutrons) are compared for fractionated irradiation in respect to the probability of the cure of cancer and relative to the probability of the destruction of normal tissues. A human model is developed employing both demonstrated and deduced values for the parameters of the cellular radiation response, the oxygen effect, and cell population kinetics. It is presumed that such a study may have value for predicting the relative effectiveness of fast neutron beam irradiation for human cancer radiotherapy. (auth)

6750 INTRACAVITARY IRRADIATION OF CARCINOMA OF THE CERVIX UTERI, USING A LINEAR DISTRIBUTION OF SOURCES. Holodny, Edward I.; Kowalsky, William P.; Barsa, Jean M.; Sischy, B.; Newall, Joseph (St. Vincent's Hospital and Medical Center, New York. Highland Hospital, Rochester, N. Y.). Radiology; 97: 127-31(Oct 1970).

The dosimetry of a linear arrangement of sources in treating carcinoma of the cervix was described and compared to a typical forniceal placement. The dose distribution was more uniform throughout the length of the linear system and may be more ac-

curately integrated with external irradiation. The lead shields incorporated in the linear applicator and the use of ^{137}Cs as the radiation source halve the dose to the rectum. The total-body and bone-marrow doses were reduced, yet the pelvic dose was higher. (auth)

6751 METHOD FOR VARYING THE EFFECTIVE ANGLE OF WEDGE FILTERS. Tatcher, M. (Rambam Government Hospital, Haifa, Israel). Radiology; 97: 132(Oct 1970).

By irradiating a given site partly with and partly without a wedge filter in position, it is possible to produce a spectrum of wedge angles smaller than the nominal wedge angle in cases where angles of a size not generally employed would give a better dose distribution, such as in providing tissue compensation when treating the larynx using parallel opposed fields. (auth)

6752 CONTROLLED STUDY OF PREOPERATIVE IRRADIATION IN CANCER OF THE SIGMOID COLON AND RECTUM. PRELIMINARY REPORT. Roswit, Bernard; Higgins, George A.; Keehn, Robert J. Radiology; 97: 133-40(Oct 1970).

A prospective controlled study to determine the clinical effect of low-dose preoperative irradiation on clinically operable patients with histologically proved adenocarcinoma of the colon or rectum was initiated. Preoperative irradiation had no demonstrable effect upon the incidence of surgical complications or upon mortality during the first three months after resection. The pathologist identified lymph nodes in 24% of the resected x-ray cases and in 38% of the controls. Lymphatic invasion and serosal penetration were also reported significantly less frequently for the irradiated patients. No remarkable differences were seen when survival from operation was computed for subgroups of resected cases. (auth)

6753 POSTIRRADIATION PNEUMONITIS FOLLOWING COMBINED THERAPY FOR MALIGNANT PULMONARY TUMORS. Teichmann, V. (Charles Univ., Prague). Rozhl. Chir.; 49: 108-13(Mar 1970). (In Czech).

The development of postradiation pneumonitis following combined therapy (radiation and surgical treatment) of pulmonary malignancies is discussed. A detailed analysis is presented of the problems concerning postradiation reaction from the morphologic aspect, the evolution of changes taking place, and associated pathophysiologic manifestations. Consideration of the circumstances closely linked with the evolution of this reaction, as well as consideration of the given therapeutic procedure, produced a number of recommendations. These concern the selection of indications for the combined treatment and the prevention and follow-up of postradiation pneumonitis. Some more general questions are also touched upon, in particular the need for objective evaluation of the true significance of combined therapy for cases of malignant pulmonary tumors. In this connection the need for differentiated selection of patients suitable for this type of therapy is stressed. (tr-auth)

6754 BASIC PHENOMENA IN X-RAY THERAPY OF MALIGNANT TUMOURS. de Waard, R. H. (Univ. Hospital, Utrecht). Radiol. Clin. Biol.; 39: 381-96(1970).

Survival curves obtained in experiments on cultured cells suggest that x rays can cause cell death by two mechanisms. The occurrence of these mechanisms, one of which can be induced by single and the other by double hits, can be characterized by two parameters a and b. The theory presented here is based on the assumption that similar mechanisms act in tumor cells and normal cells in vivo. It is shown that this theory explains the most fundamental empirical data of x-ray therapy concerning: the tolerance of normal tissue, and the curability of tumors by fractionated treatment, if a and b are given appropriate values. The essential point is that the value of a appears to be considerably larger in tumor cells than in normal ones, whereas the value of b should be rather similar in the two cell types. The effect of fractionation is that it reduces the influence of the non-specific b-mechanisms, so that the difference between the specific a-mechanisms becomes predominant. (auth)

6755 TEN-YEAR EXPERIENCE WITH LINEAR ACCELERATOR IRRADIATION OF CANCER OF THE NASOPHARYNX. Thompson, Ronald W.; Doggett, R. L. Scotte; Bagshaw, Malcolm A. (Stanford Univ., Calif.). Radiology; 97: 149-55(Oct 1970).

In 47 previously untreated patients with nasopharyngeal cancer, curative doses of linear accelerator radiation were administered. The absolute survival rate without clinical evidence of disease was 27/47 (58%). More deaths resulted from intercurrent disease and metastases (11 patients) than from persistent primary and/or regional nodal disease (nine patients). Aggressive therapy of clinically involved and uninvolved cervical node disease is supported by 76% (28/37) and 98% (38/39) control rates, respectively. Curative irradiation by a variety of techniques resulted in an average survival of three years after retreatment, with only one local tumor recurrence at death. Second primary tumors occurred in six of 58 patients (10%). (auth)

6756 MANAGEMENT OF RECURRENCES OF MALIGNANT TUMORS OF THE UTERINE CERVIX BY 42 MeV BETATRON. Coucourde, F.; Maestro, A. (Univ., Pavia, Italy). Radiol. Clin. Biol.; 39: 407-18(1970).

The first results obtained by radiotherapy with 42 MeV photons of the betatron in 33 cases of recurrent tumors of the cervix are reported. Early results were satisfactory in all patients, even in those with extensive pelvic infiltrates. The usefulness of radiotherapy with ultra hard photons to achieve satisfactory immediate and palliative results is emphasized. (auth)

6757 IRRADIATION OF THE THYMUS GLAND IN THE THERAPY OF MULTIPLE SCLEROSIS. Wender, Mieczyslaw. Neurol. Neurochir. Psychiat. Pol.; 4: 65-8(Jan-Feb 1970). (In Polish).

The significant but previously not sufficiently well recognized role of the thymus gland on the course of multiple sclerosis was investigated. Twenty patients suffering from this disease were treated by x irradiating the thymus gland at a total dose of 1000 R, administered in 10 sessions during one day at the rate of 100 R each. Following up the effects two years after the treatment, it was found that eight patients did not exhibit additional aggravation of the disease and in 12 cases the aggravations fluctuated between 0.5 and 2.0. The results thus indicate that irradiation of the thymus gland does not affect the natural course of the disease. No complications were noted during the therapy. All patients took the radiation treatment well except two who complained of general weakness and one who vomited. The treatment was discontinued in that case. (TTT)

Blast and Thermal Effects

6758 (ABCC-69-70) ATOMIC BOMB CASUALTY COMMISSION ANNUAL REPORT, JULY 1, 1969–JUNE 30, 1970. (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). 290p. Dep. NTIS.

Activities of the Atomic Bomb Casualty Commission from July 1969 to July 1970 are reviewed. A total of 77 studies related to evaluation of the health status of persons exposed to atomic bombs at Hiroshima and Nagasaki are summarized briefly. The studies include the offspring of exposed individuals. Studies that indicate an increasing number of neoplasms in relation to aging of the exposed population are discussed briefly. (C.H.)

6759 (AD-697936) URBAN CASUALITY ESTIMATION AND THE CIRCULAR COVERAGE FUNCTION. II. Report on Themis Signal Analysis Statistics Research Program. Read, Campbell R. (Southern Methodist Univ., Dallas, Tex. Dept. of Statistics). 17 Oct 1969. Contract N00014-68-A-0515. 14p. (THEMIS-SMU-TR-46). CFSTI.

A single-weapon attack on a city having a circular normal distribution of population about the origin is considered; the aiming error is assumed to be circular normal about the point of impact. The Circular Coverage Function, will figure in the evaluation of the expected number of casualties. The expected casualties when the impact point is given are evaluated and an expression for the damage function, modified to include aiming error, is obtained. (USGRDR)

6760 (CONF-691106-, pp 547-79) RBE OF NEUTRONS IN JAPANESE SURVIVORS. Jablon, S.; Fujita, S.; Fukushima, K.; Ishimaru, T. (Atomic Bomb Casualty Commission, Hiroshima (Japan)); Auxier, J. A. (Oak Ridge National Lab., Tenn.).

From Symposium on neutrons in radiobiology, November 11-14, 1969, Oak Ridge, Tennessee.

Estimates of the RBE for fission neutrons as compared with weapons γ radiation of about 3 to 5 for epilation and bleeding, around 6 for leukemia induction, and 1 or 2 for axial lens opacities were calculated for residents of Hiroshima and Nagasaki exposed to radiations from atomic bombs. Difficulties in obtaining the data and the reliability of the RBE estimates are discussed. Nevertheless, the Hiroshima–Nagasaki experience is unique and whatever their weaknesses, the data from these cities are, and hopefully will remain, all that is available, and we shall continue to try to refine them and extract from these tragedies information which will be valuable to mankind. (auth)

Radiation Effects on Animals

Refer also to abstracts 6461, 6634, 6642, 6643, 6664, 6670, and 6689.

6761 (CONF-691106-, pp 230-43) RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST NEUTRON RADIATION FOR DAM-

AGE TO CULTURED MAMMALIAN CELLS. Barendsen, G. W.; Broerse, J. J. (Gezondheidsorganisatie TNO, Rijswijk (Netherlands). Radiobiologisch Instituut).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

The relative biological effectiveness (RBE) of fast neutrons relative to 300 kV x rays depends on various factors. For impairment of the capacity for unlimited proliferation of cultured mammalian cells, this dependence was studied with fast neutrons of different energies. The results demonstrated that the RBE is a function of the dose and the dose rate, the highest RBE-values being measured at low doses and low dose rates. In fractionated treatments, repair of sub-lethal damage was shown to be less important after neutron irradiation as compared with x-irradiation. In addition the oxygen enhancement ratio of fast neutrons was generally smaller for fast neutrons as compared with x rays, but does not vary significantly between neutron energies of 1 and 15 MeV. These data were discussed in relation to the energy dissipation patterns of neutrons of different energies. RBE-values of fast neutrons obtained for different types of cells, irradiated in identical conditions, were found to differ considerably. This might be explained by assuming that damage to the reproductive capacity of these cell types requires different local energy densities. For radiation-induced non-lethal damage in cultured mammalian cells expressed by the reduction of sizes of clones from cells, that after irradiation retained the capacity for unlimited proliferation, the RBE was found to be similar to the RBE for cell reproductive death. The implications of the results obtained with cultured cells for effects produced by fast neutrons and x rays in other systems were discussed, with special reference to the differences between sensitivities of various systems. (auth)

6762 (CONF-691106–, pp 244–54) RBE OF NEUTRONS IN MAMMALIAN SYSTEMS. Bewley, David K. ([Medical Research Council, London (England). Cyclotron Unit]).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

The response of mammalian cells and tissues to the fast neutron beam from the M.R.C. cyclotron is discussed. This beam is at present being used for a trial of fast neutron radiotherapy. Precise values of RBE depend critically on dosimetry. The dosimetry of fast neutron beams is at a more rudimentary stage than that of x and γ rays. While the rad of neutrons may vary from center to center there is clearly an advantage in keeping to the results of one center. The mean energy of the beam is about 7.5 MeV and the dose rate is about 50 rads/min at 1 meter. By placing the specimen closer to the target, dose rates of a few Krad/min can be achieved. The RBE of the neutron beam is discussed as a function of the main variables governing its variation, namely dose level, type of tissue, chemical modifier, and dose-rate. (auth)

6763 (CONF-691106–, pp 483–97) ROLE OF FACTORS MODIFYING NEUTRON DAMAGE IN IRRADIATION OF MAMMALIAN CELLS IN VITRO AND IN VIVO. Berry, Roger J. (Medical Research Council, Oxford (England). External Scientific Staff).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Neutron energy, dose-rate, scattering, and degradation of neutron energy by tissue-equivalent materials, the proportion of the total dose, and the presence or absence of oxygen interact to modify the survival of mammalian cell reproductive capacity following irradiation of cultured cells with fast neutrons. In addition, significant biological factors affect the response observed: cell type and stage in the cell cycle are the most important of these. The magnitude of the differences caused by these factors seems to be smaller for fast neutron irradiation than for x or γ radiation, although there is some evidence that fast neutrons of intermediate ionization density may leave a higher proportion of the survivors slowly-growing, than does an x ray dose which leaves a comparable proportion of the initial cell population reproductively intact. (auth)

6764 EFFECT OF STRONG INHOMOGENEOUS MAGNETIC FIELDS ON SERUM-FREE CELL CULTURES. Pumper, R. W. (Univ. of Illinois, Urbana); Barnothy, J. M. pp 61–5 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

Serum-free cell cultures of rabbit myocardium and of mouse lung fibroblast isolate were exposed for two to seven days to a static magnetic field of 14,600 Oe with a 5000 Oe/cm gradient. The cells in the magnetic field stained much more intensely than the controls and there was a significant increase in the growth rate of the exposed cells. A graph is presented to show effects of the magnetic field on growth of cells. (H.L.W.)

Invertebrates

Refer also to abstracts 6679, 6682, and 6683.

6765 EFFECT OF A CONSTANT MAGNETIC FIELD ON INVERTEBRATE NEURONS. Russell, D. R. (General Dynamics, Forth Worth , Tex.). pp 227–32 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

Suboesophageal ganglia were dissected from cockroaches, Periplaneta americana, and exposed to a magnetic field of 6600 Oe. The spontaneous neural activity was amplified and recorded on magnetic tape. For analysis of the data, recorded pulses were played back, amplified, and converted into appropriate input signals. Activity ratios were obtained by calculating the ratio of pulse rate out of the field to pulse rate in the field. It was found that exposure to the magnetic field caused a 17 to 27% inhibition in spontaneous firing rates. A discussion is presented of possible mechanisms that might contribute to the inhibitory effect. It is suggested that there may be a decrease in production of transmitter substance or an increase in the enzyme responsible for inactivating the transmitter substance. (H.L.W.)

6766 STRAIN SENSITIVITY OF SILKWORM EGGS TO KILLING AND MUTATION BY ULTRAVIOLET LIGHT. Murakami, Akio (National Inst. of Genetics, Misima, Japan). Radiat. Res.; 44: 146–53(Oct 1970).

A comparison of strain sensitivity to uv light among different x-radiosensitive silk worm strains was carried out to obtain a better understanding of the nature of ionizing radiation effects on living organisms. After mature oocytes and eggs in early cleavage stages were irradiated with varying doses of uv embryonic mortality and mutation frequency at pe: re egg color-specific loci were measured. A consistent, positive correlation was found between mortality and uv-radiosensitivity to mutation induction. No positive correlation was found between uv- and x-radiation sensitivities for either biological effect. (E.E.H.)

6767 EFFECTS OF GAMMA RADIATION ON HETERODERA ROSTOCHIENSIS. Evans, K. (Rothamsted Experimental Station, Harpenden, Eng.). Nematologica; 16: 284–94(1970).

Cysts, second stage larvae, and adult males and females of H. rostochiensis were exposed to 2, 4, 8, 16, 32, and 64 kilorads of γ radiation. Hatching from cysts exposed to potato root-diffusate for 3 days before irradiation was decreased, and some eggs were killed after only 2 kilorads, but hatching from air-dried cysts was stimulated by the smaller doses in one experiment. Irradiation of second stage larvae had no effect on their activity, but irradiation of either cysts or larvae impaired development of the F_1 generation: fewer cysts with fewer eggs than those in unirradiated controls were formed, and many of the eggs lacked normal larvae. Adults were more resistant than hatched larvae or larvae within cysts to irradiation. Small doses affected the fertility of adult females more than that of males, probably because the primary oocytes continue dividing after mating, whereas all the sperm is formed by the time the males leave the roots. Larvae from irradiated cysts competed poorly with those from unirradiated cysts when potato plants were inoculated with mixtures of the two. (auth)

Vertebrates

Refer also to abstracts 6635, 6638, 6640, 6641, 6645, 6647, 6650, 6653, 6655–6659, 6662, 6666, 6671, 6675, and 6710–6714.

6768 (BNL-tr-359) COMBINED EFFECT OF X-RAY IRRADIATION AND MICROWAVES ON BONE MARROW. Sevast'yanova, L. A.; Potapov, S. L.; Adamenko, V. G.; Vilenskaya, R. L. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Biol. Nauki; No. 6, 46–8(1969). 6p. Dep. CFSTI.

The phenomenon of increased resistance in animals to ionizing radiation due to microwave irradiation has been described in the literature (A. S. Presman, 1968). It has been shown (S. Michaelson, 1963) that a preliminary irradiation of animals with microwaves in the centimeter range reduces by several factors the mortality resulting from subsequent effects of ionizing radiation. The data published in the literature were obtained by using wavelengths in the meter, decimeter, and centimeter range. The effect of x irradiation on bone marrow using microwaves in the millimeter range was investigated and the diminishing effects of the latter on the former are reported. (E.R.B.)

6769 (CONF-691106–, pp 140-50) ACUTE AND PROLONGED CHRONIC EFFECTS OF MOUSE SKIN IRRADIATION WITH ACCELERATED HEAVY IONS. Leith, John T.; Aceto, Henry Jr. (California Univ., Berkeley).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Male Swiss Webster mice were exposed to whole-body skin irradiation. Experimental results utilizing an energy degraded helium-ion beam whose maximum residual range corresponds to specific depth intervals in skin were obtained. These results include an analysis of mortality with doses over the range of 100 to 500 microns depth in skin, and an analysis of the effect of dose-rate on the response. The clinical symptomology and time pattern of mortality are well defined. Physiological studies of the radiation response include analysis of water intake, plasma and red blood cell volumes, and general hematological indices. Survivors of helium irradiations performed at the 500 micron depth in skin were retained for a long term study of effects of radiation on longevity. Also, the possible predisposition of mice to increased radiosensitivity induced by such skin irradiation was examined by observing the response of mice to whole-body ^{60}Co γ irradiation immediately following helium-ion skin irradiation. (auth)

6770 (CONF-691106–, pp 207-29) EXPERIMENTAL MAMMARY NEOPLASMS: A COMPARISON OF EFFECTIVENESS BETWEEN NEUTRONS, X- AND GAMMA-RADIATION. Vogel, Howard H. Jr.; Zaldivar, Robert (Tennessee Univ., Memphis. Coll. of Medicine).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Single, whole-body exposures to fission neutrons, of 10 to 250 rads, were followed by the development of at least one mammary neoplasm in 73 to 87% of irradiated Sprague–Dawley/ANL female rats. In contrast to similar experiments using low LET radiations (both x and γ rays), there was no evidence of a linear dose-effect relationship. The data supported an RBE (x/n) at least as high as 20. Unirradiated rats showed 48% mammary tumor incidence during their lifetime, no neoplasms appearing within the first ten months. After a single, whole-body exposure to only 5 rads of fission neutrons, 63% of the rats developed mammary neoplasia within 27 months of exposure. Histopathological analysis of 102 mammary neoplasia in 95 irradiated rats showed 72 cases of benign tumors (70.6%), 11 cases of sarcomas (10.8%) and 19 cases of carcinomas (18.6%). Thus the ratio of benign to malignant neoplasms was found to be approximately 7 : 3. Among 26 unirradiated control rats, nine benign tumors (34.6%), no sarcomas, and three carcinomas (11.5%) were diagnosed. The fibroadenoma was the most common mammary neoplasm following neutron irradiation, in contrast to the adenofibroma reported after x and γ irradiation. Of 127 female rats irradiated with 5 to 35 rads of fission neutrons, seven demonstrated palpable mammary neoplasms within approximately 100 days after irradiation. Six of these tumors were diagnosed histopathologically: five were adenocarcinomas, and one was a fibrosarcoma. It is apparent that the adenocarcinoma is the most common type of neoplasm induced by neutron exposure. In one case, an adenocarcinoma was palpable only nine days after neutron irradiation. (auth)

6771 (CONF-691106–, pp 255-67) CURRENT RESEARCH ON FACTORS INFLUENCING RBE FOR MAMMALIAN LATE EFFECTS. Darden, E. B. Jr. (Oak Ridge National Lab., Tenn.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Factors influencing relative biological effectiveness (RBE) for late somatic effects in mice are summarized. The influence of radiation quality on the disease pattern, particularly age-specific incidence, for five major neoplastic diseases is compared in RF mice, using data from experiments with 14-MeV neutrons, 60-MeV protons, and 300-kVp x rays. Preliminary results confined to one dose level (185 to 200 rads) show no striking differences between radiations. All three radiations were capable of inducing thymic lymphoma, myeloid leukemia, and ovarian tumors, as expected from earlier work in this strain. X rays were most effective for the induction of myeloid leukemia, and 14-MeV neutrons for the induction of ovarian tumors. Leukemias other than thymic and myeloid, and lung tumors were prevalent in all treatment groups and showed a negative reaction, if any, to radiation. Factors influencing radiation-induced lens opacities in the mouse are summarized as to the influence of dose level on the RBE of fission neutrons. In general, the RBE increases with decreasing dose, climbing to 20 or 25 at the lowest neutron dose level for which comparable x ray is available. (auth)

6772 (CONF-691106–, pp 275-9) EFFECTS OF NEUTRONS ON LARGE ANIMALS. Alpen, Edward L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Over the last twenty-five years a large body of research relating to the effects of neutron irradiations on mammalian systems has accumulated. The great majority of these studies, however, was carried out on smaller rodents, principally mice, with a smattering of results on rats and hamsters. These trends have, of course, been dictated by the unavailability of neutron sources of adequate field size or dose rate. Experiments aimed at exploring the relative effect of high energy neutrons in large animals are reviewed. The sources of these data are principally the studies on dogs originating at the Naval Radiological Defense Laboratory, San Francisco, and studies in goats carried out at the Medical Research Council Laboratory in Harwell, England. (auth)

6773 (CONF-691106–, pp 435-50) RECOVERY IN THE MOUSE AFTER NEUTRON-IRRADIATION: EVALUATION OF INJURY AND RECOVERY USING SPLIT-DOSE LETHALITY AND RREPOPULATION OF COLONY-FORMING UNITS. Ainsworth, E. J.; Larsen, R. M.; Kendall, K.; Leong, G. F.; Krebs, J. S.; Mitchell, F. A. (Naval Radiological Defense Lab., San Francisco, Calif. Argonne National Lab., Ill.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

The effects 250 kVp x rays, fission-spectrum 2.5 neutrons, and 14.7 MeV neutrons on mice are compared. Thirty-day lethality estimates and D37 determination for marrow colony-forming units (CFU) were completed for x rays, fission, and fast neutrons. Recovery from radiation injury was measured in split-dose lethality experiments with mice exposed to x rays, and fission spectrum neutrons. Recovery of the hematopoietic system after x or fission spectrum neutron irradiation was evaluated by following the reappearance of leukocytes in the peripheral blood and CFU repopulation in the femur. The relationship between CFU survival and $LD_{50/30}$ in mice exposed to x rays and neutrons of different energies is discussed. (auth)

6774 (RLO–1927-50) RADIATION SENSITIVITY OF NEW ZEALAND BLACK MICE: RELATION TO THE DEVELOPMENT OF AUTOIMMUNE DISEASE AND NEOPLASIA. Morton, Jane I.; Siegel, Benjamin V. (Oregon Univ., Portland. Dept. of Pathology). [1970]. 11p. Dep. NTIS.

Young New Zealand Black (NZB) mice manifested extremely high resistance to the lethal effects of acute exposures to x radiation, with an $LD_{50/30}$ of 964 R at 30 days of age and of 856 R when 90 days old. Coombs' positive 9-month-old NZB mice, in contrast, were highly susceptible ($LD_{50/30}$ = 543 R), possibly because of anemia-stimulated erythropoiesis leading to a depletion of stem cells. The radiation resistance noted for young NZB mice along with previous observations of their immunologic hyperresponsiveness would lend credence to the concept that NZB mice possess an unusually large pool of hematopoietic stem cells, an abnormality which may predilect to the later development of autoimmune disease and neoplasia. (auth)

6775 (UCD–472-117) ANNUAL REPORT, FISCAL YEAR 1970. (California Univ., Davis. Radiobiology Lab.). Jun 1970. Contract AT(04-3)-472. 121p. Dep. CFSTI.

Separate abstracts were prepared for 21 of the 34 papers in this annual report dealing with radioisotope uptake by Beagle dogs, and its effects on mortality, reproduction, morphology, and pathology of Beagle dogs. (P.B.M.)

For abstracts of individual papers see: 6622, 6623, 6638, 6665, 6675, 6702, 6719, and 6776–6789.

6776 (UCD–472-117, pp 11-16) EFFECT OF FRACTIONATED X-IRRADIATION ON THE OVARY OF YOUNG PUPS. Andersen, A. C.; Simpson, Miriam E. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

In a pilot study 10R and 30R fractionated x rays (total 200R and 600R) were equally effective in sterilizing 13 Beagle pups exposed between 2 and 40 days of age. The ovaries in both groups were similar and had either absent or bizarre shaped follicles. (auth)

6777 (UCD–472-117, pp 17-26) EFFECT OF FRACTIONATED X-RAY EXPOSURES TO THE OVARY OF FETAL MONKEYS. Andersen, A. C.; Nelson, Vicki Giles; Simpson, Miriam E. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

A preliminary study indicates that the developing ovary in fetal monkeys is sensitive to fractionated doses of x irradiation. Eight pregnant Bonnet monkeys were exposed to 270R x irradiation in 10R events twice weekly between the 2nd and 5th months of gestation. Histologic examination of one gonad from two female infants revealed afollicular ovaries. (auth)

XUM

6778 (UCD-472-117, pp 31-3) PITUITARY ABNORMALITIES IN 7-YR-OLD BEAGLES AFTER X-IRRADIATION, PRODUCTION, OR OVARIECTOMY. Warner, Marlene R.; Faulkin, L. J. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Whole pituitary glands of control and x-irradiated 7- to 8-yr old female Beagles were bisected at necropsy. Associations are presented between incidence of lesions and x irradiation, ovariectomy, and reproductive status. Lesions are being confirmed histologically. (auth)

6779 (UCD-472-117, pp 34-40) EFFECT OF RADIOIODINE AND X-IRRADIATION ON BEAGLE PUPS. McGinnis, Terrance; Book, S. A.; Bustad, L. K.; Fuller, J. M. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

The results of studies performed on young Beagles 16 and 24 months post-exposure to thyroid doses of 1500 or 4500 rads from ^{131}I, the former with or without 200R whole-body x-irradiation, are presented. Thyroid gland monitoring suggests that ^{131}I may induce damage at the 4500-rad level. Thirteen additional animals were added to the experimental groups, along with six controls. (auth)

6780 (UCD-472-117, pp 49-50) ^{90}Sr CONCENTRATION IN SEMEN AND PLASMA OF BEAGLES. Della Rosa, R. J.; Munn, Susan L.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Strontium-90 concentrations in plasma and semen of dogs, both on and off feed, were found at a ratio of 10:1. No impairment in ability to sire pups was observed in two males of the highest level, although reduced motility in these animals was a consistent finding. (auth)

6781 (UCD-472-117, pp 51) RADIOGRAPHIC CHANGES IN SKELETONS OF BEAGLES ADMINISTERED ^{90}Sr AND ^{226}Ra. Williams, R. Jean; Hanson, R. J. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Radiographic injury scores for radionuclide-treated Beagles are again compared by dose, treatment, and time. The ^{226}Ra injected dogs show the same pattern of osseous lesions as previously reported. The highest levels of ^{90}Sr treated dogs are beginning to manifest bone tumors. (auth)

6782 (UCD-472-117, pp 57-63) TUMORS INVOLVING BONE IN BEAGLES FED TOXIC LEVELS OF ^{90}Sr: PATHOLOGY AND RADIOBIOLOGIC IMPLICATIONS. Goldman, Marvin; Pool, R. R.; Williams, R. Jean. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Twelve cases of radiation-induced tumors involving bone were evaluated, providing information on possible differences and similarities in the types of canine bone lesions seen after continual ^{90}Sr β irradiation of the skeleton. The types of neoplasms are summarized and identified with skeletal radiation dosage levels of 3,7000 to 13,000 rads. (auth)

6783 (UCD-472-117, pp 64-72) MYELOPROLIFERATIVE DISORDERS IN ^{90}Sr FED BEAGLES. Bulgin, Marie S.; Wilson, F. D.; Shifrine, Moshe; Goldman, Marvin (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Data are given on the myeloproliferative disorder associated with high-level ^{90}Sr feeding of Beagles. Observations include blood and bone marrow studies, ^{52}Fe-positron scans, ^{59}Fe and ^{51}Cr erythrokinetics, serum electrophoresis, and clinical studies. There are individual variations but results appear compatible with a myeloproliferative syndrome with a spectrum of expression. (auth)

6784 (UCD-472-117, pp 73-5) DOSE-RATE INDUCTION OF GRANULOPOIESIS IN BEAGLES WITH UNIFORM ^{90}Sr SKELETAL LABELING. Goldman, Marvin; Rosenblatt, L. S.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Beagles fed different levels of ^{90}Sr for the first 1.5 yr of life show dose-related neutropenias that are maximal at the end of the feeding period. Thereafter, neutrophil counts return toward control values. Concomitantly, local bone dose rates are being reduced by ^{90}Sr loss from bone, particularly from bone surrounding hematopoietic marrow. During the post-feeding period probit transforms of neutrophil depressions are linearly related to bone marrow dose rates. This analysis suggests that radiogenic neutropenia is determined primarily by contemporary bone marrow dose rates. (auth)

6785 (UCD-472-117, pp 76-8) EARLY MORTALITY OF BEAGLE PUPS IN THE INTERNAL EMITTER PROGRAM. Rosenblatt, L. S.; Bielfelt, S. W.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Neonatal mortality (0 to 3 days), weaning mortality (0 to 42 days), and litter size at birth were studied for all litters produced for the main internal emitter program. Dose levels were balanced with respect to the genetic contribution of sires. Results indicated that mortality rates among pups whose dams were fed ^{90}Sr were not significantly different from those for pups of control dams. There was no evidence for a ^{90}Sr dose response. Average litter sizes did not vary greatly between dose levels; again, no ^{90}Sr feeding effect was discerned. (auth)

6786 (UCD-472-117, pp 79-81) EFFECTS OF HIGH ^{90}Sr BODY BURDENS ON REPRODUCTION AND PUP SURVIVAL IN BEAGLES. Della Rosa, R. J.; Yates, D. G.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Pups whelped by dams with body burdens up to 400 μCi ^{90}Sr showed no increase in mortality from birth to weaning. No effect of the sire's body burden on reproduction or survival was noted. (auth)

6787 (UCD-472-117, pp 82-3) SURVIVAL OF BEAGLES IN THE INTERNAL EMITTER PROGRAM. Rosenblatt, L. S.; Bielfelt, S. W.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Cumulative survival rates were recomputed as of February, 1970. In dose levels below D4 and R4, survival rates were similar to those of the two control groups. To 9 yrs of age the 95% confidence interval for cumulative survival rate for controls and lower-level dogs was 93 to 97%. At higher levels of ^{90}Sr feeding or ^{226}Ra injection lower survival rates were observed, due primarily to radioinduced neoplasms, myeloproliferative syndrome (MPS), and osteosarcoma. (auth)

6788 (UCD-472-117, pp 84-6) MORBIDITY AND MORTALITY IN RADIONUCLIDE-TREATED BEAGLES. Dollarhide, Nancy E.; Chrisp, C. E. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Clinical cases for 1969 to 70 are summarized and mortality data are presented for dogs on the ^{90}Sr and ^{226}Ra experiments. A case of myeloproliferative disease was seen at the D3 level for the first time in a dog that had received ^{90}Sr throughout life. (auth)

6789 (UCD-472-117, pp 108-11) EFFECTS OF CONTINUOUS ^{89}Sr INGESTION BY MICE. McClatchy, Cherryl; Lane, J. R.; Wright, J. F.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

From Annual report, fiscal year 1970.

Strontium-89 was fed continuously to three strains of mice to determine the effects of dose rate and age at irradiation (gestation vs. weaning) on tumor induction. RFM mice were susceptible to lymphomas and reticulum cell sarcoma and resistant to bone tumors, which were observed mainly at the higher level of ^{89}Sr in C57Bl mice. Median survival times (MST) were, in general, highest for the C57Bl strain, followed by the Balb/C. Survival times were lower for females; MST dropped as dose increased. When there were differences between gestation and weaning groups, the former had higher tumor incidences. (auth)

6790 EFFECTS OF THE MAGNETIC FIELD ON INTERNAL ORGANS AND THE ENDOCRINE SYSTEM OF MICE. Barnothy, M. F. (Univ. of Illinois, Chicago); Suemegi, I. pp 103-26 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

Exposure of mice to homogeneous static magnetic fields in excess of 4200 Oe, and exposure times longer than 4 days produce a disorganization and narrowing of the zona fasciculata of the adrenal cortex, a decrease in the number of megakaryocytes in the bone marrow, an increase in the number of megakaryocytes in the spleen, and an increase in the number of mitoses in liver tissues. The high statistical significance found for each of these four parameters establishes the existence of these changes in organs of mice exposed to strong magnetic fields. While some of the observed abnormalities are seen when an organism is subjected to a variety of stressors, some differences should be pointed out. Under ordinary conditions of stress the fasciculata is widened not narrowed; the number of megakaryocytes usually increases in the bone marrow and does not decrease; and, finally, while megakaryocyte proliferation with ectopic myelopoiesis in the spleen is characteristic of the reaction to neoplastic tissues and treatment with certain tissue extracts, it is not seen with

ordinary non-specific stress. Furthermore, should the magnetic field behave as a non-specific stressor, a decrease in the intensity of the effects as the time elapsing after termination of magnetic exposure is increased would be expected; such decrease in severity of the effects was observed only in the mitotic index of liver tissues. The circumstance that a change was evident in the zona fasciculata of the adrenal cortex suggests that during the exposure to a magnetic field some hormone imbalance was created. The abnormalities observed in the spleens and livers of the exposed mice could best be described as resulting from a general stimulation of the reticuloendothelial system, which, in turn, might be a manifestation of the defense mechanism of the organism against the stimulus of the magnetic environment. (auth)

6791 CHANGES IN THE ERYTHROCYTE SEDIMENTATION RATE OF RABBITS DUE TO EXPOSURE OF THE CENTRAL NERVOUS SYSTEM TO A CONSTANT MAGNETIC FIELD. Likhachev, A. I. (Inst of Physiology, Baku). pp 137-46 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

Theoretical considerations of the effects of a constant magnetic field on the erythrocyte sedimentation rate via the central nervous system are discussed. Experimental research was carried out on five groups of rabbits injected with turpentine. Two groups were placed in the magnetic field and the central nervous system of two groups was exposed to a constant magnetic field. The fifth group was not exposed to a magnetic field. Blood was taken from all animals before and after exposure to the magnetic field for measurement of the erythrocyte sedimentation rate, the hemoglobin concentration, and the leukocyte count. It was found that the sedimentation rate decreased under the influence of a constant magnetic field. Effects of the magnetic field on the central nervous system led to rapid normalization of the sedimentation rate. A table is presented to show changes in the blood picture of rabbits following action of a constant magnetic field on the central nervous system. Whereas the leukocyte count of the rabbits in the control group rose steadily as a result of the inflammation, in the rabbits exposed to a constant magnetic field on the central nervous system it rose extremely rapidly. A decrease in hemoglobin level and platelet count was observed in rabbits in which the central nervous system was exposed to a constant magnetic field. It was concluded that studies on changes in the blood picture produced by exposure to a constant magnetic field can provide data which may prove useful to the physician by aiding him in the diagnosis of diseases not only of the vascular system but also of other systems. (H.L.W.)

6792 EFFECT OF HIGH-GRADIENT, HIGH-STRENGTH MAGNETIC FIELDS ON THE EARLY EMBRYONIC DEVELOPMENT OF FROGS. Neurath, Peter W. (New England Medical Center Hospitals, Boston). pp 177-87 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

It was postulated that there are cellular components in organisms which are relatively large in volume and have a paramagnetic susceptibility larger than the rest of the tissue. Such cellular components would experience a force in a gradient magnetic field great enough to move them through the cell and to maintain a concentration gradient within the cell. This force would exist for as long as the cells continued to be exposed to a magnetic field. Ferritin is relatively paramagnetic and plays an important function in plants and animals. In order to test the effect of a magnetic field on ferritin, early embryonic growth of the frog was used as an indicator. Experiments included a search for ferritin particles and a study of iron distribution in eggs and embryos. Results showed that there was an inhibiting effect of the product of a high-strength magnetic field and gradient on the early development of frog embryos. The hypothesis that the results are caused by forces on ferritin particles was not supported. (H.L.W.)

6793 EFFECT OF MAGNETIC FIELDS UPON THE CENTRAL NERVOUS SYSTEM. Becker, Robert O. (State Univ. of New York, Syracuse. Upstate Medical Center, Syracuse, N. Y.). pp 207-14 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

A review of the literature on the effects of magnetic fields on neural functioning is presented, and the significance of this knowledge for predicting possible undesirable effects of human exposures to force fields is pointed out. Topics reviewed are: effects of alternating or modulated fields on central nervous system structures; effects of steady-state magnetic fields on the electroencephalogram; effects of field strengths of 1 to 10 G on the circadian rhythm of lower animals; effects of continuous exposure to low-field conditions on the human nervous system; and correlation of DC or steady-state potentials of nerve tissue with sensitivity to magnetic fields. (H.L.W.)

6794 INVESTIGATIONS OF THE REACTIONS OF MAMMALIAN BRAIN TO STATIC MAGNETIC FIELDS. Kholodov, Yu. A.; Alexandrovskaya, M. M.; Lukyanova, S. N.; Udarova, N. S. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). pp 215-25 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

Rabbits were exposed to 1000 Oe static magnetic fields (SMF); acoustic and optic stimuli were given simultaneously to some animals. Observations on conditioned reflexes showed that SMF was a weaker stimulus than the optical or acoustic. All properties of the magnetic conditioned reflex were weaker than the same properties of the acoustic conditioned reflex. Effects of 200 to 1000 Oe SMF on the electroencephalogram of rabbits were studied in relation to the functional state of the central nervous system. An inhibitory effect of the SMF on the electrical neuronal activity stimulated by light and sound was observed. Histological studies on the reaction of the brain to SMF showed that the neurons remained intact, but that the number of astrocytes and other glial cells was increased. (H.L.W.)

6795 PREFERENCE OF MICE TO CONSUME FOOD AND WATER IN AN ENVIRONMENT OF HIGH MAGNETIC FIELD. Russell, D. R.; Hedrick, H. G. (General Dynamics, Fort Worth, Tex.). pp 233-9 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

An apparatus was designed and constructed to study the activity and food–water intake as influenced by a permanent magnetic field of 1100 Oe as compared to a low magnetic field environment. The results showed that all eleven animals used in this study had increased food and water intakes in presence of the high magnetic field environment as compared to the low-field environment. The animals spent more time (2130.8 min) in the low magnetic field environment as compared to 1839.5 min in the high magnetic field environment. As a measure of animal activity, it was found that the animals made 20,241 trips to the high magnetic field environment compared to 17,044 trips to the low-field environment. The results indicate that the animals showed a preference toward increased activity and increased food–water intake in the high magnetic field environment. Additional numbers of animals and experimental runs on animals confronted with the same environments are needed to further verify this preference. It is also recommended that similar experiments should be conducted on higher mammals. (auth)

6796 VECTORCARDIOGRAM AND AORTIC BLOOD FLOW OF SQUIRREL MONKEYS (SAIMIRI SCIUREUS) IN A STRONG SUPERCONDUCTIVE ELECTROMAGNET. Beischer, Dietrich E. (Naval Aerospace Medical Center, Pensacola, Fla.). pp 241-59 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

A description is given of a superconductive magnet consisting of a large cylindrical container, the nitrogen Dewar, which encloses the helium Dewar with the magnetic coil. A magnetic field strength of 150,000 Oe can be generated. Electrodes were placed on the chest and legs of two squirrel monkeys and vectocardiograms were recorded before and after placing the monkeys in the magnetic field. Measurements were taken at field strengths of 40, 65, and 100 kOe. The heart rate was determined from the ECG, and aortograms were prepared. Changes in the ECG and the aortogram are described. The T wave was completely overshadowed by the strong signal generated by the aortic blood flow in the magnetic field. Characteristics of the flow potential are described, and the maximum scalar value of the flow potential was linearly related to the strength of the magnetic field. These potentials were considerably influenced by the respiratory cycle. Difficulties and advantages of superconductive magnets in electrophysiology are discussed. Interpretation of flow potential is discussed from the standpoint of general principles, cardiac blood flow during isometric contraction, arterial and venous blood flow, quantitative method for determining the velocity of aortic blood flow, flow dipole used as electrical reference source, and possible cardiac stimulation by the flow potential. (H.L.W.)

6797 RADIATION $LD50_{(30)}$ OF PIKAS (OCHOTONA PRINCEPS) IN THE NATURAL ENVIRONMENT AND IN CAPTIVITY. Markham, O. D.; Whicker, F. W. (Colorado State Univ., Fort Collins). Contract AT(11-1)-1156. Amer. Midland Natur.; 84: 248-52(Jul 1970).

Estimates of the $LD50_{(30)}$ from ^{60}Co radiation were made for a group of pikas (Ochotona princeps) held in captivity and for another group observed in the natural environment near the summit of

Mount Evans, Colorado. The $LD50_{30}$ estimate was 560 R (438 to 717 R; 95% confidence limits) for captive animals and 380 R (250 to 578 R) for pikas at Mount Evans. Mean survival time for irradiated pikas was 9 to 13 days in captivity and 5 to 7 days in the natural environment. Results are discussed in relation to artificial stresses resulting from captivity and natural stresses such as intraspecific competition and predation. (auth)

6798 EFFECTS OF X RADIATION AND ACTINOMYCIN D ON INTESTINAL EPITHELIUM OF DOGS. Concannon, Joseph P.; Summers, Roy E.; Cole, Christine; Weil, Carrol; Kopp, Ursula; Sigdestad, Curtis P. (Allegheny General Hospital, Pittsburgh). Radiology; 97: 157-64(Oct 1970).

Combination of actinomycin D and irradiation of the upper portion of the abdomen of dogs in doses which by themselves produce no significant clinical, histologic, or biochemical abnormalities may result in death of the animals. Factorial analysis of crypt-cell data demonstrated a statistically significant independent effect for actinomycin and radiation ($p < 0.001$). An actinomycin-radiation interaction was not demonstrated, and it is thus proposed that increased effects observed in this investigation were due to simple additivity of the effects of actinomycin and radiation. Mortality appeared related not only to total actinomycin and radiation dose, but also to daily radiation exposure. (auth)

6799 RETROGRADE LESIONS OF THE RETINA AFTER EXPOSURE TO IONIZING RADIATION. Kanbay, G. G. (Scientific Research Inst. of Ophthalmology, Azerbaydzhan, USSR). Azerb. Med. Zh.; No. 11, 9-13(1969). (In Russian).

The initial stage of radiation sickness is marked by angiopathy, as manifested by change in the diameter of the preretinal and retinal blood vessels, thickening of the arterial walls, and obliteration of the lumens of some vessels. The rods and cones become affected in the latent period. Lethal and sublethal radiation doses result in necrosis and disintegration of the rods and cones. At the climax of radiation sickness, the outer nuclear layer begins to widen due to consolidation of the granules and to their migration beyond the external limiting membrane toward the outer plexiform layer. If the sickness is mild, the process may extend only this far, but if more severe, the cones become involved. If the sickness is very severe, the rods and cones become involved at the same time. During the resolution period, histological sections reveal the presence of regenerative phenomena with a proliferation of nerve structures in the ganglion and nerve fiber layers alongside degenerative, atrophic, and necrobiotic processes. Involvement of the individual layers of the retina in radiation sickness occurs in the opposite direction to their ontogeny, while the compensatory-adaptive phenomena repeat it. (JPRS)

6800 EFFECT OF X-IRRADIATION OF SELECTED AREAS OF THE HEAD OF THE NEWBORN RAT ON GROWTH. Mosier, H. David Jr.; Jansons, Regina A. (Univ. of California, Irvine. Memorial Hospital, Long Beach, Calif.). Radiat. Res.; 43: 92-104(Jul 1970).

X irradiation of the whole head of the newborn rat resulted in growth retardation, the degree of which depended on the age of the animal and the dose of radiation. The mechanism involved in the growth impairment was investigated. Long-Evans black hooded rats (1126) were either irradiated or used as littermate controls. The areas of the head that were irradiated were: whole head; right and left halves; lateral outer zones; transverse bands in anterior, middle, and posterior locations; and midsagittal bands. The rats were all irradiated at two days of age except one small group which was irradiated at one day of age. The radiation doses ranged from 600 to 2000 R. The results indicate that bilateral irradiation of structures near the midline in the general area of the hypothalamus will produce growth retardation. Irradiation of the pituitary gland is not required for the growth failure. Evidence against the possibility that the growth disturbance is caused by a disturbance of well-known endocrine functions or nutritional deficiency is summarized. The implications of the present findings in the problem of growth controls are discussed. (auth)

6801 SURVIVAL OF MURINE LEUKEMIA CELLS IN VIVO AFTER IRRADIATION IN VITRO UNDER AEROBIC AND HYPOXIC CONDITIONS WITH MONOENERGETIC ACCELERATED CHARGED PARTICLES. Berry, Roger J. (Churchill Hospital, Oxford). Radiat. Res.; 44: 237-47(Oct 1970).

Murine P-388 leukemia cells were irradiated in vitro under aerobic or hypoxic conditions with monoenergetic track-segments of beams of accelerated deuterons or alpha particles at ionization densities (LETs) of 6–86 keV/μm of unit density absorber, and the survival of their reproductive capacity was assayed in vivo. No significant protection was conferred by hypoxia at the highest LET studied, in contrast to the only similar published studies using human-derived T-1 cells in which significant hypoxic protection was observed up to LETs of 140 to 165 keV/μm. Similar differences between the response of murine P-388 cells and hyman T-1 cells to fast neutrons of different energies are discussed. (auth)

6802 COMPARISON OF SURVIVAL TIMES OF MONKEYS AND RATS EXPOSED TO PULSED AND STEADY-STATE REACTOR RADIATIONS. Levich, C.; Seigneur, L. J.; Strike, T. A.; Hansen, C. L. Jr.; Schlaak, J. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res.; 44: 108-15(Oct 1970).

Macaca mulatta monkeys and Sprague–Dawley rats were unilaterally exposed to whole-body doses of γ-neutron radiations from a TRIGA reactor. Doses of 2075, 4150, and 12,450 rads were used in the monkey studies. Doses to the rats ranged from 9400 to 66,000 rads. The animals were exposed in two ways. The steady-state animals were irradiated at a dose rate of approximately 1000 rads/minute. The other animals were exposed to a single pulse of radiations. The pulse was about 15 msec wide at half-amplitude. The average dose rate under the pulse was of the order of 10^6 rads/second. At doses sufficient to cause death within 2 days, the ordering of deaths was significantly different between pulsed and steady-state irradiated monkeys with the pulsed animals preceding. The mean survival time of pulsed animals was significantly shorter than their steady-state counterparts for both species of animals. (auth)

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Refer also to abstracts 6652, 6661, 6708, 6709, 6715, 6744, 6752, 6753, 6756, 6758, 6760, and 8042.

6803 (CONF-691106–, pp 451-61) LOW ENERGY NEUTRON PRODUCED ABERRATIONS IN HUMAN CIRCULATING LYMPHOCYTES. Davy, D. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

The RBE values applicable to low damage levels following irradiation with neutrons over the energy range 0.05 to 0.40 MeV were determined. The end point studied was the in-vitro induction of chromosomal aberrations in cultured human lymphocytes. Whole blood was irradiated and cells were harvested 50 hrs after culture initiation. For x rays (250 KVP, HVL 1.2 mm Cu) the dicentric plus ring aberration frequency was of the form: $y = 6.4 \times 10^{-5} D^{1.7}$ whereas the dose kinetics were linear for all neutron irradiations. The neutrons used were produced by the Li(p,n) reaction from an 8 keV thick Li target. Exposure times ranged up to 6 hrs at a fluence rate of $\sim 10^8$ n cm^{-2} hr^{-1}. For a total dose of 200 R, no x ray dose rate effect was found for rates $\geq$ 5R/min and for dose rates below this, the effect was small. A significant dose rate effect was observable for neutrons produced by the Be(d,n) reaction at all fluence rates investigated. On regarding the Li(p,n) neutron irradiations as acute, RBE values ranged from 20 to 70. The variation of RBE with neutron energy was as predicted by the carbon bond model but the magnitudes were not. (auth)

6804 CLINICAL AND RADIOGRAPHIC ASPECTS OF RADIATION OSTEITIS. Bragg, David G.; Shidnia, Homayoon; Chu, Florence C. H.; Higinbotham, Norman L. (Memorial Hospital for Cancer and Allied Diseases, New York. Cornell Univ., New York). Radiology; 97: 103-11(Oct 1970).

Patients with radiation osteitis were studied in regard to the protean manifestations of this entity as it affects the skeleton, with emphasis on distinguishing radiation osteitis from radiation osteogenic sarcoma, metastatic bony involvement, or simple changes of disuse. Bone fragmentation, resorption, and soft tissue calcification may mimic the appearance of a radioinduced osteogenic sarcoma. In the absence of infectious or traumatic complications, an area of known radiation osteitis that suddenly changes in appearance, becomes symptomatic, or is associated with a mass lesion should be considered neoplastic. (auth)

6805 ONE CASE OF RADIATION RETINOPATHY. Kaneko, Akihiro; Tanishima, Teruo (Tokyo Univ.). Rinsho Ganka; 24: 273-6(Feb 1970). (In Japanese).

Case study of radiation injuries following radiotherapy is presented. Lymphoblastic sarcoma in eye was treated using 5130R of ^{60}Co γ delivered over 33 days. After three months, a decrease in visual acuity was observed. Funduscopic examination and fluorescein angiography results are described. (NSA of Japan) (TSS)

6806 SOME CONSIDERATIONS ON LEUKEMIAS DEVELOPED AFTER THERAPEUTIC IRRADIATION. Kurokawa, Shigeki; Kitabatake, Takashi (Niigata Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi; 29: 1081-6(Nov 1969). (In Japanese).

From 1954 to 1966, 52 cases of leukemia, following therapeutic irradiation, were reported in Japanese literature. In comparison with leukemia in the general population, radioinduced luekemia was more frequent in the aged. A statistical survey did not support the general concept in Japan that AML was more frequent than other types of radioinduced leukemia. In this study, the relationship between dose and latent periods was not clear. Latent periods showed nearly a log-normal distribution in radioinduced cancers other than leukemia. (auth) (Japan)

6807 SYMPTOMATIC CONSTRICTIVE PERICARDITIS DEVELOPING 45 YEARS AFTER RADIATION THERAPY TO THE MEDIASTINUM: A REVIEW OF RADIATION PERICARDITIS. Haas, John M. (Fitzsimons General Hospital, Denver). Amer. Heart J.; 77: 89-95(Jan 1969).

A case presumed to represent symptomatic constrictive pericarditis, developing 45 yr after childhood irradiation of the chest was reported. At the age of nine, the patient received radiotherapy to the chest for something she thought related to her thymus and developed symptoms compatible with severe radiation sickness. The unknown quantity of irradiation of the mediastinum apparently resulted in arrest of growth in the structures in the chest wall, rib cage, and breasts, with secondary radiation changes to the skin. There was no history of chest trauma or illnesses to arouse suspicion of acute pericarditis. Preoperative and postoperative studies of tissue and fluid cultures of the pericardium as well as histological examination of the pericardium failed to demonstrate another possible etiological agent. It was presumed that this patient developed fibrous pericarditis secondary to radiotherapy. (BBB) (TSS)

6808 LEUKEMIA AND THYROID CARCINOMA: A COMPARISON OF THE LATE MORTALITY RISKS FROM REACTOR ACCIDENTS. Otway, Harry J. (Los Alamos Scientific Lab., N. Mex.); Erdmann, Robert C. Nucl. Safety; 11: 482-9(Nov-Dec 1970).

The literature regarding the late somatic effects of ionizing radiation was reviewed and estimates were made of the mortality risk for leukemia and thyroid carcinoma based on a linear theory of carcinogenesis. The estimates were one death per million persons per rad of ^{131}I thyroid irradiation and 30 deaths per million persons per rad from leukemia due to whole-body irradiation. These numbers are applied to the dose–distance relations for hypothetical design accidents calculated for pressurized-water and fast breeder reactors. It is concluded that for these postulated accidents and reactor types the long-term risk of death from leukemia may be comparable to or greater than that from thyroid carcinoma. (auth)

6809 THYROID NEOPLASIA AS LATE EFFECT OF EXPOSURE TO RADIOACTIVE IODINE IN FALLOUT. Conard, Robert A. (Brookhaven National Lab., Upton, N. Y.); Dobyns, Brown M.; Sutow, Wataru W. J. Amer. Med. Ass.; 214: 316-24(12 Oct 1970).

Accidental exposure of people of Rongelap Island to radioactive fallout and particularly to radioactive iodines in the fallout has resulted in the development of thyroid abnormalities in 21 of 67 of these people, three with malignant lesions, 16 with benign adenomatous nodules, and two with atrophy of the gland with hypothyroidism. The preponderance of lesions occurred in children exposed at less than 10 years of age who had received a greater thyroid exposure. Growth retardation associated with hypothyroid tendency was noted in some children who appear to be responding favorably to thyroid hormone medication. Thyroidectomy, partial to complete, has been carried out on 18 patients. Risk for thyroid cancer from radioactive iodine exposure in this group does not appear to be very different from that reported following x irradiation. (auth)

Radiation Effects on Plants

Refer also to abstracts 6634, 6636, 6637, 6640, 6664, 6669, 6670, 6672–6674, 6677, 6678, 6680, 6681, 6689, 6825, and 6826.

6810 (CONF-691106-, pp 520-30) ROLE OF MODIFYING FACTORS IN NEUTRON SEED IRRADIATION. Conger, B. V.; Constantin, M. J. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

From Symposium on neutrons in radiobiology, November 11–14, 1969, Oak Ridge, Tennessee.

Himalaya barley seeds adjusted to various water contents were subjected to various doses of unmoderated fission neutrons from the HPRR. Under anoxic conditions there was no significant difference in radiation-induced seedling injury for seeds containing 1.8 to 14.5 percent water. Injury increased with an increase in seed water content between 14.5 and 32.2 percent even if the seeds were kept at low temperature (0 to 10°C) during equilibration and treatment. Very dry seeds (2.2 percent water) exposed in vacuo to neutrons and then soaked in oxygenated water at 0°C for 16 hours were more damaged than comparable seeds soaked in oxygen-free water. The OER of 1.34 decreased to 1.00 with increasing seed water to 9.9 percent. Oxygen sensitivity in very dry seeds did not decrease during post-irradiation storage and additional doses of γ rays up to 1000 R did not significantly increase the oxygen effect. (auth)

6811 (RLO-2221-T-2-2) EFFECT OF FAR-RED RADIATION ON MALEIC HYDRAZIDE-INDUCED CHROMOSOMAL ABERRATIONS IN VICIA FABA. Smock, Sharon; Nilan, R. A. (Washington State Univ., Pullman. Dept. of Agronomy). [1969]. Contract AT(45-1)-2221. 13p. Dep. NTIS.

The effects of far-red radiation on chromosome aberration frequencies in the roots of Vicia faba seedlings induced by the radiomimetic chemical, maleic hydrazide (MH), were studied. Maleic hydrazide was chosen because it is an effective and well known mutagen in Vicia, and because it induces non-random breakage in heterochromatic regions. The results showed that the far-red effect does not produce potential breaks in the chromosomes. Reaction mechanisms affected by far-red irradiation at various wavelengths in light and complete darkness are discussed. (C.H.)

6812 SENSITIVITY OF SOME PLANT MATERIAL TO MAGNETIC FIELDS. Dunlop, Douglas W.; Schmidt, Barbara L. (Univ. of Wisconsin, Milwaukee). pp 147-70 of Biological Effects of Magnetic Fields. Vol. 2. /Barnothy, Madeleine F. (ed.). New York; Plenum Publishing Corp. (1969).

The results of these studies demonstrate that prolonged exposure to heterogeneous magnetic fields of 500 to 4500 Oe may produce the following responses in adventitious roots of Allium, Narcissus, and Coleus: inhibition of cell reproduction followed by death of embryonic tissue and accompanied by senescence of all root tissues; and anomalous development of certain cells and tissues, including nuclear, cytoplasmic, and cell wall abnormalities, with omission of some normal developmental cell types. Pithophora, a much less complex organism, necessarily showed much less complex effects of exposure to magnetic fields. However, prolonged exposure to heterogeneous magnetic fields of 800 to 1500 Oe may induce the following behavior in Pithophora: reduced and markedly abnormal growth of filaments, accompanied by premature and excessive formation of akinetes. It is concluded that magnetic fields of a strength well in excess of the geomagnetic field generated an environment unfavorable to growth and normal development, and promotive of early maturation and senescence of cells, tissues, and organisms. (auth)

6813 FORECAST CALCULATIONS OF FUTURE RADIOSTRONTIUM AND RADIOCESIUM LEVELS IN FODDER AND CEREALS. Csupka, Stefan; Carach, Jozef; Petrasova, Maria; Cechvala, Lubomir (Hygiene and Epidemiology Inst., Bratislava). Jad. Energ.; 16: 345-8(Oct 1970). (In Czech).

The results of fallout measurements in soils, fodder, and cereals were taken as a basis for the estimation of unknown parameters of the regression analysis equation. The parameters, the so called proportional factors, were applied in forecasting the future ^{90}Sr and ^{137}Cs levels in fodder and cereals. For the future radioactive fallout, two models were compiled, namely a model with constant and one with decreasing fallout per year. On the basis of these two proposed models an estimation of future radionuclide levels in fodder and cereals was worked out. (auth)

6814 EFFECTS OF SPACE FLIGHT FACTORS AND GAMMA RADIATION ON FLOWER PRODUCTION AND MICROSPORE DIVISION AND DEVELOPMENT IN TRADESCANTIA. Marimuthu, K. M.; Schairer, L. A.; Sparrow, A. H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot.; 10: 249-59(Jun 1970).

The interaction between ^{85}Sr gamma radiation (average exposure approximately 220 R) and space flight factors (vibration, acceleration, weightlessness, etc.) on the number of flowers produced and on microspore division and development was studied in Biosatellite II. In the actual flight one package of 32 young Tradescantia clone 02 plants was irradiated during the two-day flight, and another package was used as an unirradiated flight control. Two similar packages, one of which was irradiated, were maintained as non-flight controls in a similar spacecraft at the launch site. Various postflight experiments were conducted in an attempt to attribute the effects observed in the orbited plants to specific flight factors. In these postflight ground tests, plants were grown simultaneously in both the flight and non-flight spacecraft under conditions similar to those recorded during the actual flight. In the clinostat and additional vibration experiments indi-

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vidual packages rather than the whole spacecraft were used. After each treatment, open flowers were collected for at least 26 days. Some of the morphological and cytological effects observed in the flight material can be attributed to low gravity (weightlessness) and others to the internal environment of the spacecraft. Those effects attributed to weightlessness include (1) an increase in number of flowers produced in both orbited samples compared with their non-orbited controls and (2) various kinds of mitotic abnormalities associated with altered spindle behavior in microspores. Effects attributed to spacecraft environmental factors such as the increased concentration of ethylene measured in the flight vehicle include (1) an increase in the mortality rate of microspores, (2) an increase in the frequency of developmental abnormalities indicated by a change in the number and shape of the nuclei in young pollen, and (3) an increase in flower bud blasting which led to a change in the pattern of flower production. (auth) (UK)

6815 ANATOMICAL STUDIES IN THE GENUS ORYZA. III. Roy, J. K.; Richharia, R. H. (Central Rice Research Inst., Cuttack, India). Indian J. Genet. Plant Breed.; 27: 101-6(1967).

Seeds of rice var. A_1 35 (Oryza sativa L. Sub sp. indica) were exposed to fast neutrons for 2 hr. The plants raised from the treated seeds were studied anatomically. Exposure to fast neutron induced dwarfism and also affected the internal tissue, particularly the parenchymatous cells, which became irregular in size and shape. Reduction in the amount of structural tissue was also found. It seems that due to irradiation, the process of secondary thickening in the parenchyma was affected. Occurrence of intracortical roots in rice was also reported. (Indian Sci. Abstr.)

6816 RADIOSENSITIVITY STUDIES WITH WOODY PLANTS. II. SURVIVAL DATA FOR 13 SPECIES IRRADIATED CHRONICALLY FOR UP TO 8 YEARS. Sparrow, A. H.; Schwemmer, Susan S.; Klug, E. E.; Puglielli, Leanne (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 44: 154-77(Oct 1970).

A study of the lethal effects on woody angiosperms and gymnosperms of chronic ^{60}Co γ irradiation began in 1960 and continued on a yearly basis through the summer of 1969. Changes in survival of 13 species were determined yearly during irradiation periods extending up to 8 yrs. The lethal dose expressed as R/day or accumulated kR, required to produce 50% survival (LD_{50}), decreased with increasing time, but the decreases were small after the third yr. The fact that constant LD_{50} was approached suggested that plants become quite tolerant of a certain level of irradiation, perhaps through highly effective repair systems. The correlation between interphase chromosome volume (ICV) and radiosensitivity was established at various end points for both woody and herbaceous plants. The woody plants, as a group, were found to be more sensitive than herbaceous ones of comparable ICV. This correlation was used in choosing the correct exposure series for each species to be irradiated and in predicting the sensitivity of additional species of woody plants to γ irradiation. (E.E.H.)

Radiation Effects on Microorganisms

Refer also to abstracts 6634, 6668, 6670, 6689, and 6821–6824.

6817 RESISTANCE OF BACILLUS SUBTILIS SPORES TO INACTIVATION BY GAMMA IRRADIATION AND HEATING IN THE PRESENCE OF A BACTERICIDE. I. SUITABILITY OF VIABLE COUNT PROCEDURES. Deasy, P. B.; Kuester, E.; Timoney, R. F. (Coll. of Pharmacy, Dublin). Appl. Microbiol.; 20: 455-60(Sep 1970).

A statistical evaluation of viable count procedures utilized for obtaining treatment survival curve data for Bacillus subtilis NCTC 8236 spores is described. Within the various recovery conditions tested, incubation on nutrient agar containing 1% dextrose for 48 hr at 37°C was found to promote the highest count of viable spores surviving a variety of bactericidal treatments involving gamma irradiation, heat, and chlorocresol. The count of viable spores on the medium was not significantly altered when the dextrose was added to the nutrient agar either before autoclaving or aseptically at 50 to 55°C from a solution sterilized by filtration. The volume of medium that promoted the highest count of viable spores was 20 ml per 85 mm of diameter in disposable plastic plates. Counts of viable spores were reproducible on successive batches of media. The carry-over of variable concentrations of chlorocresol into the medium from serial dilutions affected the count of viable spores. Spores in the aqueous stock suspension used for all experiments were uniformly distributed after shaking and did not diminish significantly in viability after 16 months of storage at 5°C. Grouping of indexes of dispersion, calculated from quintuplicate plate colony counts, indicated that the suitability of the viable count procedures, employed for the enumeration of spores surviving the various bactericidal treatments, tended to diminish as the level of spore inactivation exceeded 95%. (auth)

6818 RESISTANCE OF BACILLUS SUBTILIS SPORES TO INACTIVATION BY GAMMA IRRADIATION AND HEATING IN THE PRESENCE OF A BACTERICIDE. II. FACTORS AFFECTING RATES OF INACTIVATION BY PHENOLIC BACTERICIDES. Deasy, P. B.; Kuester, E.; Timoney, R. F. (Coll. of Pharmacy, Dublin). Appl. Microbiol.; 20: 461-4(Sep 1970).

Aqueous suspensions of Bacillus subtilis NCTC 8236 spores, surviving 150,000 or 300,000 rad of γ irradiation under air from a ^{137}Cs source, exhibited an enhanced rate of inactivation, compared to nonirradiated spores, when heated with different phenolic bactericides. The apparent magnitude of the enhanced inactivation rate, observed from survival curves, increased progressively with the irradiation dose applied and diminished progressively as the severity of heat treatment with 0.2% chlorocresol was increased either by raising the temperature from 70 to 90°C or reducing the pH from 8 to 6. The enhanced inactivation rate was unaffected when the concentration of sodium chloride added to 0.2% chlorocresol was altered from 0.4 to 0.8%. The enhancement effect was also observed when the heat treatment was carried out with 0.5% phenol and 0.3% m-cresol. (auth)

6819 PURIFICATION, CONCENTRATION, AND INACTIVATION OF VENEZUELAN EQUINE ENCEPHALITIS VIRUS. Gruber, Jack (Medical Sciences Lab., Frederick, Md.). Appl. Microbiol.; 20: 427-32(Sep 1970).

Venezuelan equine encephalitis (VEE) virus was purified and concentrated by chromatography of tissue culture supernatant fluids on diethylaminoethyl-cellulose columns. Stepwise gradient elution studies indicated a broad elution pattern for the virus, with recovery occurring from 0.05 to 0.7 M NaCl. Optical density, infectivity, hemagglutination (HA), and complement fixation (CF) assays indicated that complete recovery of input virus in highly purified form was possible. Single-step elution with 0.7 M tris(hydroxymethyl)aminomethane-succinate-salt buffer resulted in a virus volume decrease of 85% with a concomitant increase in infectivity and antigenicity. Recoveries consistently equaled or exceeded 100% of the input preparations. Additional purification of column-recovered virus was obtained by sedimentation of pooled virus eluates on 50% sucrose cushions. Exposure of borate saline and 0.5% histidine suspensions of purified VEE virus preparations to 6×10^6 R of γ radiation resulted in a loss of infectivity for tissue culture and a loss of lethality for weanling and suckling mice. Inactivation was an exponential function of the dosage. In contrast to infectivity, antigenicity (HA and CF) of both saline and histidine preparations was retained after irradiation with doses as high as 6×10^6 R. Purified and irradiated VEE virus preparations were successfully used for routine serological tests and are being evaluated as vaccines. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 6819.

6820 (GA-9924) IONIZING RADIATION FOR THE TREATMENT OF MUNICIPAL WASTE WATERS. Final Report, February 26, 1969–February 28, 1970. Whittemore, W. L.; Compton, D. M. J.; Black, S. J. (Gulf General Atomic, Inc., San Diego, Calif.). 28 Feb 1970. Contract AT(04-3)-167. 165p. Dep. NTIS.

A program was undertaken to investigate the effects of ionizing radiation chiefly on real waste waters and sludges from municipal treatment plants. Such pieces of apparatus and techniques as were necessary for the performance of the tasks were developed and used to study: oxidation and modification of organic impurities; sedimentation and air flotation; and filterability of sludges. A major task of the present work was to compare the economics of radiation waste treatment with the more standard techniques. Where appropriate on this project, synergism was considered. Though a detailed radiochemical model is needed for evaluating quantitatively any true synergistic interactions, a meaningful evaluation of economic synergism can always be made. From an overview of the radiation treatment of waste waters, it was concluded that doses of 100 to 1000 krads caused significant effects similar to those achieved from more usual methods of treatment, but that the effects of a radiation treatment of waste waters sometimes saturated at too low a value to be economically useful, were usually more costly than the similar standard technique, and sometimes introduced unwanted secondary effects. (auth)

6821 (TID-25545) APPLICATION OF RADIATION-PASTEURIZATION PROCESSES TO PACIFIC COAST FISHERY PRODUCTS. Annual Report, November 1, 1968–October 31, 1969. Miyauchi, David; Teeny, Fuad (National Marine Fisheries Service, Seattle, Wash. Technology Lab.). Oct 1970. Contract AT(49-11)-2058. 30p. Dep. NTIS.

Supplementary dosimetry data for research work that was completed during the previous several years were obtained. Ten series of experiments, which simulated the geometries used in γ irradiating fish samples and Clostridium botulinum type E inoculated-pack studies, were run to determine the maximum and minimum doses absorbed by the fish samples. To determine the benefits in terms of storage-life extension and maintenance of quality of radiation-pasteurized fish fillets shipped across country, English sole fillets that were irradiated at doses as low as approximately 100 kilorads were shipped by truck from Seattle, Washington to Gloucester, Massachusetts. The irradiated fillets had a refrigerated shelf life of about nine days longer than the corresponding nonirradiated control samples. (auth)

6822 (UCD-34-P-80-6) RADIATION TECHNOLOGY IN CONJUNCTION WITH POSTHARVEST PROCEDURES AS A MEANS OF EXTENDING THE SHELF LIFE OF FRUITS AND VEGETABLES. [Annual Report], February 1, 1967–January 30, 1968. Maxie, E. C.; Sommer, N. F.; Brown, D. S. (California Univ., Davis. Dept. of Pomology). Dec 1970. Contract AT(11-1)-34. 173p. Dep. NTIS.

Test shipments of strawberries irradiated to 200 kilorad (Krad) showed a substantial reduction in amounts of unmarketable fruits in comparison to unirradiated fruits subjected to near ideal handling and shipping conditions. Heat treatments prior to irradiation sensitize the conidia of Botrytis cinerea rot (grey mold of strawberries) to irradiation. Gamma radiation in combination with heat gave encouraging results as a means of processing fresh apple juice. Gas chromatographic studies showed little alteration of the volatile fractions in irradiated apple juice. These results complement taste-panel data where panelists find little flavor difference between irradiated and unirradiated juice. Heat treatments of sweet cherries had no adverse effect on the texture of irradiated or unirradiated fruit. Doses as high as 1100 Krad were ineffective in softening abnormally firm, dried dates. Varying dose rates exerted no statistically significant effect on the loss of ascorbic acid in lemon fruits. Doses of 25 Krad stimulated opening of brown mushrooms, while 50 and 100 Krad were inhibitory. Taste-panel data indicated no significant difference in flavor between irradiated and unirradiated samples. Doses of 0 to 8 Krad showed progressive inhibition of growth in harvested asparagus spears. Doses above 4 Krad gave shorter storage life (12 days at 4 Krad vs. 7 days in the range of 150 to 700 Krad and 10 days in the range of 8 to 50 Krad). Simulated transit and irradiation alone and in combination increased the susceptibility of tomato fruits to mechanical injury. The tight-fill method of packing shows promise as a means of alleviating the problem of transit injury in both irradiated and unirradiated tomatoes. Preliminary tests indicate that the adverse effects of irradiation on peppers preclude any commercial use of the process. A steam pasteurizer for heat treatment of fruits was designed, tested, and the effectiveness of moist steam in comparison to immersion in hot water compared. Engineering data on heat transfer between the two methods are compared. During the summer of 1967, 55 tons of strawberries and 26 tons of bananas were irradiated in the Mobile Gamma Irradiator for feeding studies preparatory to preparation of petitions for clearance by the Food and Drug Administration. (auth)

6823 USE OF GAMMA RADIATION FOR THE ELIMINATION OF SALMONELLA FROM FROZEN MEAT. Ley, F. J. (Wantage Research Lab., Eng.); Kennedy, T. S.; Kawashima, K.; Roberts, Diane; Hobbs, Betty C. J. Hyg.; 68: 293-311(Jun 1970).

The use of a γ radiation process for the elimination of Salmonella from frozen meat is considered with particular reference to the treatment of boned-out horsemeat and kangaroo meat imported into the UK and intended for use as pet food. Examination of dose/survival curves produced for several serotypes of Salmonella in frozen meat shows that a radiation dose of 0.6 Mrad will reduce a population by at least a factor of 10^5. The influence on the radiation resistance of Salmonellae of such factors as preirradiation growth in the meat and temperature during irradiation have been examined and considered. It is also demonstrated with both preinoculated and naturally contaminated meat that postirradiation storage in the frozen state does not lead to the revival of irradiated Salmonellae. The properties of Salmonella survivors deliberately produced in meat using conditions of irradiation designed to simulate a commercial process are studied after six recycling treatments through the process. There were no important changes in characteristics normally used for identification of Salmonella but radiation resistance was lowered. Survivors grown in situ in meat after irradiation showed an abnormally long lag phase, and removal of competitive microflora in meat by the radiation treatment can influence the growth of Salmonellae. (38 references.) (auth)

6824 PSEUDOMONADS AND ACHROMOBACTERS IN THE SPOILAGE OF IRRADIATED HADDOCK OF DIFFERENT PRE-IRRADIATION QUALITY. Laycock, R. A.; Regier, L. W. (Fisheries Research Board of Canada, Halifax, Nova Scotia). Appl. Microbiol.; 20: 333-41(Sep 1970).

The effect of initial quality of fish on postirradiation (100 krad) changes in the bacterial flora of haddock fillets during aerobic storage at 3°C was investigated, with emphasis on the Pseudomonas and Achromobacter groups. The quality was related to the length of time the eviscerated fish were stored in ice prior to filleting. Increased numbers of organisms, in particular Pseudomonas putrefaciens, were found initially on fillets cut from older fish. Pseudomonads were reduced by 2 to 3 log orders by irradiation, and achromobacters and gram-positive isolates predominated in the immediate postirradiation flora. Little difference could be detected in either types or relative proportions of organisms occurring during storage of unirradiated fish of different quality. Pseudomonads outgrew achromobacters and dominated the spoilage flora in all cases. After spoilage, however, the growth rate of pseudomonads declined markedly. In irradiated fish, achromobacters predominated throughout storage. In fish of better initial quality, bacterial numbers were 1 to 2 log orders higher at spoilage than in their unirradiated counterparts and in the poorer quality of irradiated samples. The increased number of organisms was accompanied by a radical change in the character of the predominant achromobacters. Pseudomonads were found to increase in numbers during storage of irradiated fish, in particular in poorer quality fish on which they were initially present in higher numbers. Detection of pseudomonads, even when present in high numbers, was limited by the identification techniques normally used. (auth)

6825 STUDIES ON THE SPROUT INHIBITION AND BIOCHEMICAL CHANGES OF ONIONS BY GAMMA-IRRADIATION. Kim, Hyong Soo; Park, Nou Poung; Cho, Han Ok; Choi, Eon Ho; Lee, Heung Shik; Kim, Young Mu (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul); 9: No. 2, Pt. 2, 95-103(Apr 1970). (In Korean).

Two varieties of onions, Pai Chong (Early maturing variety) and Cheon Ju Hwang (Late maturing variety), were irradiated at one week, and at two and three months after harvest by ^{60}Co γ rays. Effects of radiation on sprout-inhibition, rot control, and chemical contents during storage were investigated. In onions irradiated a week after harvest, 4 to 8 krads was sufficient to inhibit subsequent sprouting almost completely. When they were irradiated 2 or 3 months after harvest, however, there was little inhibition by 12 krads. Rot was little affected by low-dose irradiation. Changes of total volatile sulfur compound after 4 to 8 krads irradiation decreased less than in the control group and this tendency was similar to that of moisture content. (auth)

6826 RADIO RESISTANCE OF BYSSOCHLAMYS FULVA ASCOSPORES AS SHOWN BY STORAGE TESTS. Partsch, G.; Altmann, H. (Inst. of Biology, Seibersdorf, Austria). J. Food Sci.; 35: 251-2(May-Jun 1970).

Flasks of apple, grape, and orange juice were inoculated with spores of Byssochlamys fulva and treated with 100 to 240 kRad of ^{60}Co γ radiation. Flasks were incubated at 37°C and examined daily for formation of mycelium. Storage tests and survival curves of ascospores on agar were made. Graphs are presented to show effects of radiation on germination and growth. At doses of 140 kRad and above growth occurred in orange juice after one week, in apple and grape juice only after two weeks. At 200 kRads the number of infections in apple juice decreased and above 200 kRads they disappeared completely. Orange juice continued to show mycelial development even at doses above 200 kRads. (H.L.W.)

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METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 6490, 6492, and 6511.

6827 (RISO-225) METALLURGY DEPARTMENT ANNUAL PROGRESS REPORT FOR THE PERIOD ENDING MARCH 31st, 1970. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1970. 40p. Dep. NTIS (U. S. Sales Only).

The Danish fuel element development is mainly concerned with uranium-dioxide/zircaloy fuel elements for water-cooled power reactors. In-pile fuel testing is performed in the Halden boiling-water reactor, HBWR, Norway, and in the DR 3 reactor at Risö. The Danish irradiation program at Halden comprises a total of ten fuel assemblies. The maximum burn-up achieved so far is 11,600 MWd/t. In the DR 3 test fuel pins are irradiated under more severe conditions and to higher burn-ups (target: 40,000 MWd/t). These tests also include fuel/cladding interaction studies and evaluation of manufacturing parameters. Long-term programs on zirconium-cladding development include corrosion testing of advanced zirconium alloys, partly in collaboration with the UKAEA, AB Atomenergi, Sweden, and the IFA, Norway. A joint program with the UKAEA on dispersion-strengthened zirconium alloys resulted in materials with a satisfactory corrosion resistance and a creep strength considerably improved compared with that of zircaloy-2. In-pile studies of the thermal conductivity of uranium dioxide are continued at Risö as a joint program with AB Atomenergi. Preparation of improved uranium-dioxide powder for pellet fabrication has been studied by varying of the precipitation parameters for ammonium-diuranate. An extensive program on pressure-vessel steel development comprising neutron irradiation and subsequent mechanical testing was carried out in cooperation with AB Atomenergi. The activities within general materials research covered theoretical and technological aspects of the mechanical behavior of metallic and ceramic materials, fundamental studies in connection with the corrosion resistance of nuclear materials, and a variety of investigation in fields such as diffusion, surface treatment, and instrumentation. A major subject of investigation is the mechanical properties of two-phase materials. For fiber-reinforced composites and dispersion-strengthened aluminum/aluminum-oxide products the work is now being extended to include creep in the mechanical properties studied on a theoretical level. Furthermore the rolling texture in face-centered cubic metals and alloys is investigated as well as the creep behavior of polycrystalline magnesium oxide. Work is also being done on the distribution of alloying elements in the oxide film of zirconium-chromium-iron alloys and on dispersion-strengthened stainless steel. (Denmark)

Corrosion and Erosion

Refer also to abstracts 6390 and 6891.

6828 (AEC-tr-7200) ON THE OXIDATION OF Zr-2 PERCENT Nb ALLOY. Tsirlin, M. S.; Khvorostinina, N. M.; Kovba, L. M. Translated from Vestn. Mosk. Univ., Ser. II. Khim.; No. 3, 80-5(May - Jun 1969). 12p. Dep. NTIS.

The kinetics of oxidation of Zr–2% Nb alloy was investigated in the temperature range 550 to 1000°C. Results of metallographic and radiographic examinations of oxidized specimens are included. (J.R.D.)

6829 (AEC-tr-7201) ANODIC OXIDATION OF THE Ti-Zr ALLOYS IN THE REGION BELOW THE OXYGEN EVOLUTION POTENTIAL. Nakata, Koreaki; Iida, Yoshio. Translated from Denki Kagaku; 37: 366-9(May 1969). 11p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 32018.

6830 (CEA-N-1341, pp 129-220) CORROSION STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969–November 1969.

The study of the problems concerning the steam generator of fast-neutron reactors showed the influence of surface states and transformations on the behavior of both ferritic steels in water at 350°C (evaporator) and austenitic steels in steam at 365°C (super heater). The influence of various factors on the cracking of Inconel 600 type alloys under stress was studied in water at 350°C. In the field of the corrosion problems connected with spent fuel reprocessing plants, a study was made on the behavior of stainless steel Uranus 5 in the presence of graphite. The properties of Ti and Zircaloy-2 were also studied. A study of the pool storage of spent fuel elements of EDF type confirmed the validity of the sodium carbonate solution (1 g/l) adjusted to pH 11.5 by sodium hydroxide. Research on the desalination of seawater showed the important part played by the oxygen content on the corrosion of various materials (stainless steels, Ti, and Cu alloys). Structural studies made by electron microscopy and diffraction showed the influence of intergranular carbide precipitation in very low carbon alloys on their intergranular corrosion in oxidizing media, and the effect of the σ phase in stainless steels containing Mo on their oxidation resistance in steam at 600°C. It was necessary to pursue a certain number of corrosion studies relative to the graphite-gas reactors. The influence of CO_2 pressure on U oxidation was established. Specific tests were made on the behavior of magnesium alloys in CO_2 containing appreciable quantities of water vapour. As a part of a preliminary programme on high temperature reactors, studies were undertaken on the compatibility of various materials with the usual impurities of helium, at temperature ranges from 400 to 900°C. A first helium circuit under atmospheric pressure was put into service. Most of these studies required in-pile tests in order to take into consideration any effect of neutron or gamma irradiation. In the fast-neutron reactor field, research was carried out on the corrosion of Cr ferritic steels by liquid sodium circulation. A first series of tests at 475°C was completed. Finally, an automatic calculation system based on Fortran programs and specially adapted to the problems was developed. (France)

6831 (COO-2069-5) A STUDY OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM IN CHLORIDE ENVIRONMENTS. Quarterly Report, September 1, 1969–November 30, 1969. Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). 23 Jun 1970. Contract AT(11-1)-2069. 44p. Dep. NTIS.

Results of circulating autoclave tests are reported along with those from transient dissolution studies, and experiments define the effects of nitrogen addition on the stress corrosion cracking behavior. Circulating autoclave studies were conducted at 200°C in 10 ppM Cl^- + 10 ppM O_2. Specimens failed both by localized pitting depending on the alloy composition. A review of the literature on the subject of transient dissolution has been completed and is included. The applicability to the present state of the art is evaluated. Nitrogen additions are shown to promote the formation of protective film. (auth)

6832 (SC-DR-70-164) OXIDATION OF CERTAIN REFRACTORY ALLOYS. Mottern, D. J. (Sandia Labs., Albuquerque, N. Mex.). Nov 1970. 18p. Dep. NTIS.

Several refractory metals being considered for isotope capsule structural members were subjected to an oxidizing atmosphere at various temperatures. Results indicate that Ta and Mo alloys oxidize rapidly above 1000°F. The Nb alloy WC-3015 appears to have much better oxidation properties in the temperature regime in which the metals were tested. (auth)

6833 (TID-25599) COMPATIBILITY OF VANADIUM ALLOYS WITH CARBIDE FUELS. Whitlow, G. A.; Chang, J. Y.; Deklever, R. C.; French, P. M.; Hodge, M. H. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). [1970]. 23p. Dep. NTIS.

An experimental program is described, the objective of which was to examine the compatibility of three developmental vanadium alloys with several carbide fuels in the presence of a sodium bonding medium. In 3500-hour compatibility tests at 800°C, some incompatibility was observed between three vanadium alloys and sodium bonded carbide fuels. The formation of an oxycarbide phase on the fuel pellet surface by reaction of the oxygen in the sodium bond with the fuel is thought to be the mechanism for the postulated carbon absorption and observed metallographic and microhardness changes in the vanadium alloys. There are indications that less incompatibility occurs with $Cr_{23}C_6$ modified (U,Pu)C than with hyperstoichiometric (U,Pu)C or stoichiometric UC fuels. (auth)

6834 TANTALUM OXIDATION IN THE HIGH-FREQUENCY DISCHARGE OXYGEN PLASMA. Mikhalkin, V. S.; Odynets, L. L. (Petrozavodsk State Univ., USSR). Elektrokhimiya; 6: 359-61 (Mar 1970). (In Russian).

Kinetics of Ta oxidation in a high-frequency electrodeless discharge in oxygen were studied along with electric properties of produced oxide coatings. The similarity of kinetic laws of anodic

oxidation in plasma and the anode oxidation in electrolytes suggest the similarity of mechanisms of oxide formation. (R.V.J.)

6835 EFFECT OF OXYGEN IN SODIUM ON VANADIUM AND VANADIUM ALLOYS. Klueh, R. L.; Devan, J. H. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals; 22: 389-98(Dec 1970).

Vanadium-base alloys are being considered as potential fuel cladding materials for sodium-cooled fast-breeder reactors. The mechanical and corrosion properties of vanadium alloys in sodium are strongly affected by oxygen impurities in the sodium. Vanadium and vanadium alloys readily absorb oxygen from liquid sodium at 500 to 700°C when the sodium contains 5 to 10 ppM of oxygen, depending upon the chemistry of the alloy. Alloys containing titanium and aluminum absorb oxygen with the simultaneous formation of a subsurface hardened zone. The depth of this zone depends on time, temperature, oxygen content of the sodium and alloy chemistry. In the case of pure vanadium or vanadium containing chromium or niobium, oxygen absorption occurs somewhat faster and without the formation of a pronounced hardened zone. The published corrosion results for vanadium–titanium and vanadium–aluminum were examined in terms of internal oxidation. Internal oxidation occurred when oxygen dissolved in the alloy and reacted with the dissolved titanium or aluminum to form TiO_2 or Al_2O_3 which precipitated. This precipitate gave rise to the hardened zone. It is shown that the kinetics of hardened zone formation obey the internal oxidation model proposed by Wagner, when no vanadium oxide scale forms on the external surface, and obey the model proposed by Rapp and Colson when an external scale forms. (auth)

6836 INVESTIGATION OF CORROSION STABILITY OF PLATINUM, TANTALUM, TITANIUM, AND STAINLESS STEEL TO MELTS OF ORGANIC ACIDS. Aleksandrov, Yu. I.; Novgorodtseva, V. I.; Chepeleva, E. V. Zh. Prikl. Khim.; 43: 1610-11(Jul 1970). (In Russian).

It was established that the corrosion stability of Pt, Ta, Ti, and steels of the type Cr, Nb, and Ti depend on the properties of the metal, acid, and time of metal in the acid solution. It was also found that under identical conditions, Pt and Ta possessed the best corrosion resistance. Titanium was found to be sufficiently resistant for short contact with aggressive media. An oxide film covering on the surface of Ti was more highly resistant than surfaces without the oxide film. (tr-auth)

6837 SELECTION OF NEW ZIRCONIUM ALLOYS FOR HIGH TEMPERATURE TERPHENYLS. Imarisio, G. C. (EURATOM-CCR, Ispra, Italy); Cocchi, M.; Faini, G. J. Nucl. Mater.; 37: 257-75(Dec 1970).

The corrosion of four new zirconium alloys in terphenyl was evaluated between 380 and 420°C in comparison with Zircaloy-2 and Zr/2.5 wt % Nb. The new alloys tested were: Zr/1.5 wt % Cr; Zr/1.0 wt % Cu/0.4 wt % Fe; Zr/1.4 wt % Cu/0.4 wt % Fe; Zr/0.8 wt % Fe/0.8 wt % V. The effects of the more important parameters; temperature, time of exposure, concentrations of water and of chlorinated impurities, on the corrosion of the above six alloys were measured according to a statistical design. The statistical analysis of the results showed clearly the superiority in this environment of the Zr-Cu-Fe alloys, followed by Zr/2.5 wt % Nb. The oxidation and hydriding rates observed around 400°C for the best alloys were very acceptable, although not easily estimable in the present investigation because of the smallness of their values. (auth)

Preparation and Fabrication

Refer also to abstracts 6486, 6496, and 6498.

6838 (CALT-822-17) BIBLIOGRAPHY ON ALLOYS QUENCHED FROM THE LIQUID STATE. Duwez, Pol (California Inst. of Technology, Pasadena. W. M. Keck Lab. of Engineering Materials). Dec 1970. Contract AT(04-3)-822. 13p. Dep. NTIS.

A new technique was developed in 1959 for quenching liquid alloys at very high cooling rates. A bibliography of 163 references is presented on this technique; the references are arranged according to the year, from 1960 to 1970. (D.L.C.)

6839 (CEA-Bib-187) PRESSES: HYDROSTATIC AND ISOSTATIC PRESSING. Moulet, Elisee (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Aug 1970. 71p. (In French and English). Dep. NTIS (U. S. Sales Only).

Selected documentary references concerning presses and hydrostatic and isostatic pressing are presented. The period covered is from 1935 to 1969 inclusive. Indexes are included on authors, subjects, periodicals, reports, patents, congress, and books. 229 references. (auth)

6840 (CEA-N-1341, pp 123-8) ELECTROCHEMISTRY STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Semiannual report of the Chemistry Department, No. 8, June 1969–November 1969.

Developments are reported for studies on: production of tungsten crucibles by electroforming; ion exchange processes between Pyrex glass and the LiCl–KCl eutectic; and the deposition of Cr–Ni by thermal diffusion and corrosion by saline mist. (P.C.H.)

6841 (LA-4512) STUDIES ON THE U–Pu–Zr ALLOY SYSTEM FOR FAST BREEDER REACTOR APPLICATIONS. Harbur, D. R.; Anderson, J. W.; Maraman, W. J. (Los Alamos Scientific Lab., N. Mex.). Aug 1970. Contract W-7405-eng-36. 14p. Dep. NTIS.

Pure U–Pu–Zr alloys are prepared by conventional melting and casting techniques using NbC- or Y_2O_3-coated graphite crucibles. The centerline porosity and inverse segregation of zirconium in castings can be minimized by chill-casting. The as-cast material may be hot extruded. The extruded product, although brittle up to 280°C, is plastic above 450°C. The alloys are very hard at ambient temperatures (400 dph). The thermal conductivity ranged from 0.03 to 0.07 cal/sec-cm-°C (at 110 and 892°C, respectively). The densities ranged from 16.6 g/cm^3 for U–15 wt % Pu–6.8 wt % Zr to 15.0 g/cm^3 for U–15 wt % Pu–13.5 wt % Zr. For the same composition range, the liquidus temperature increased from 1240 to 1425°C and the solidus increased from 1105 to 1195°C. Chemical homogenization is accomplished by heat treatment in the γ phase (above 700°C). A thermal gradient (500 to 750°C) causes mass ion transport of zirconium. Anisotropic growth and density decrease result from repeated thermal cycles through the phase transformations. (auth)

6842 (RFP-1564) SURFACE TREATMENT OF 304L STAINLESS STEEL. Johnson, Thomas C.; Faber, L. Harry (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 10 Dec 1970. Contract AT(29-1)-1106. 4p. Dep. NTIS.

Preparation of the surface of machined 304L stainless steel parts prior to welding, plating, and other operations is a common manufacturing process. One common method of preparation is by immersion in a solution containing nitric acid and a fluoride ion additive. This process removes small amounts of metal from surfaces exposed to the acid solution. An experimental investigation to determine the process parameters affecting metal removal rate by this preparation process is described. Temperature and nitric acid concentration of the acid bath were found significant to metal removal rate; concentration of the fluoride ion additive was not significant to metal removal rate. Metal removal rate was approximately proportional to temperature raised to the third power, and inversely proportional to nitric acid concentration. (auth)

6843 URANIUM ALLOYS. (to Compagnie Pour l'Etude et la Relisation de Combustibles Atomiques). British Patent 1,213,581. 25 Nov 1970. Priority date 30 Dec 1966, France.

A modification of the quaternary U–Cr–Si–Zr alloy in British Patent No. 1,045,019 is proposed that makes it possible to obtain a fine, equi-axed, and non-oriented grain structure upon cooling after casting. Part of the Si in the modified alloy is replaced by Mo. The composition preferred is: Cr 0.01 to 0.1 wt %, Si 0.01 to 0.1%, Mo 0.01 to 0.1%, Zr 0.025 to 0.2%, and balance U. (D.L.C.)

6844 METHOD AND DEVICE FOR ELECTROLYTIC CUTTING. Bouchet, Paulette; Chazot, Rene (to Commissariat a l'-Energie Atomique). British Patent 1,212,102. 11 Nov 1970. Priority date 7 Apr 1967, France.

A method for electrolytic cutting is described in which an electrolyte is continuously poured through a passageway onto the workpiece to be cut. An electric current also passes through the same passageway. A liquid which is immiscible with the electrolyte is formed into a flowing film on each side of the electrolyte to confine the cutting action. The electrolyte can be acid and the outer film oil. (J.R.D.)

6845 URANIUM MARKET. Houdaille, Michel (Uranex, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 5-11(Jul-Aug 1970). (In French). (CONF-700903-2).

From 4th Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden.

A summary is made of the forecast for nuclear power plants in service in 1970, 1975, 1980, 1985. The basic data on U_3O_8 consumption in the different reactors were used to establish the U_3O_8 demand. The theoretical and real uranium consumptions of these plants in various parts of the world were worked out for 1970, 1975, 1980. Comparison between the annual production

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capacity and present consumption shows a state of over-production until 1976-77. The position of the French uranium production industry is examined: resources, mining research, production capacities and concentration methods, and cost and sale prices are given. During the next four or five years the average price of U will be about $6.5 per pound of U_3O_8, and by 1977 it will be $8 per pound (1970 dollars). (France)

6846 PLUTONIUM. Ronteix, Francois (CEA, Fontenay-aux-Roses, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 27-34(Jul-Aug 1970). (In French). (CONF-700903-4).

From 4th Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden.

The plutonium resources of the noncommunist world, nuclear strategy as related to the price of plutonium, the cost of plutonium used in light water reactors, the relationship between the price per kWh of a fast neutron reactor and that of plutonium, and French experience of plutonium fuel manufacture are examined. (France)

6847 FUEL MANUFACTURE. Saulnier, M. A. (Societe Industrielle de Combustible Nucleaire, Veurey, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 35-42(Jul-Aug 1970). (In French). (CONF-700903-5).

From 4th Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden.

The French effort has centered on the manufacture of Mg-Zr clad fuel elements for the graphite gas-cooled reactors and of sintered uranium oxide elements for the H_2O, D_2O, fast neutron and HTR reactors. French industry has developed original processes for the manufacture of rolled fuel elements for swimming pool-type reactors. (France)

6848 URANIUM METAL BY CARBON REDUCTION OF OXIDE. Wilhelm, H. A.; McClusky, J. K. (Ames Lab., Iowa). J. Metals; 21: No. 12, 51-6(Dec 1969).

Uranium metal was prepared by reacting an oxide (UO_2 or U_3O_8) with graphite powder under vacuum conditions. U_3O_8 prepared from production grade UO_2 gave the highest uranium content per unit volume of charge compared to other uranium oxide sources. The process consisted of two separate vacuum induction heating steps. The first step involved heating a stoichiometric mixture of oxide and carbon in a graphite crucible to temperatures in the range 1550 to 1950°C to prepare an electrically conducting intermediate product. The final, or refining, step to obtain the metal consisted of heating this intermediate product by self-induction at temperatures in the neighborhood of 2200°C in an urania crucible. When a mixture of U_3O_8 and carbon was heated, considerable reaction took place at temperatures well below 1000°C and some CO_2 was evolved. About 7.2 moles of carbon per mole of U_3O_8 were required for complete reduction to metal. The carbon reduction of UO_2 yielded practically no CO_2 and therefore required a carbon to oxygen ratio of unity. The quality of the final metal was essentially the same regardless of whether UO_2 or U_3O_8 was used as the starting oxide. The total carbon, oxygen plus nitrogen content in the metal was in the range of 400 ppM with better than an 80% overall yield on a 200 g of metal scale. (auth)

6849 RESISTANCE BUTT WELDING WITH MAGNETIC FORCE. EXPERIENCE IN THE USE OF A MAGNETIC FORCE WELDING MACHINE USED FOR SEALING ZIRCONIUM TUBES. Barlow, K. F.; Rollin, A. F. Weld. Metal. Fabr.; 38: 439-46(Nov 1970).

The welding process is explained and its application particularly to the welding of zirconium tubes is described. The performance of the magnet is considered in detail and the significance of measurements of magnet flux, weld current, magnet force, electrode movement and inertial forces, overall performance, and one-cycle welding discussed. The magnetic force system permits the necessary complex and rapid force variations to be achieved using orthodox electrical controls and a simple mechanical arrangement. It is felt unlikely that alternatives could compete regarding cost, precision of adjustment, and uniformity of performance. (UK)

6850 INDUSTRIAL PRODUCTION OF CERIUM MISCH METAL. Foelsch, H. Metall; 24: 755-6(Jul 1970). (In German).

The primary source of cerium misch metals is cerium chloride from monazite sand. Electrolysis was used to prepare the misch metal. The method of preparation and costs are discussed. A good commercial cerium misch metal must contain 95% rare earths. A monthly production of 100,000 kg was calculated. (M.C.G.)

6851 ROLLED NIOBIUM AND TANTALUM PRODUCTS. Meckelburg, E. Metall; 24: 796-9(Jul 1970). (In German).

Preparation of the concentrate, consolidation of the metal, and transformation of ingots to rolled products are discussed. The most important range of application of Nb and Ta is considered. (M.C.G.)

Properties Evaluations

Refer also to abstracts 6304, 6481, 6482, 6493, and 6497.

6852 (CNEA-260) INTERNAL FRICTION IN HEATED VANADIUM AT LOW AIR PRESSURE. Mondino, Manuel A.; Vassallo, Daniel; de Achterberg, Marta C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 8p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

The internal friction of polycrystalline samples of V with different oxygen contents containing microstructures similar to a β phase with a high concentration of macles was studied. These samples were obtained after heating between 10 and 24 hrs at a pressure of 5×10^{-3} Hg. The measurements of the internal friction and modulus carried to completion using a torsion pendulum in the temperature range from room temperature to 550°C showed the complete disappearance of the internal friction maximum corresponding to oxygen and nitrogen. The existence of a new internal friction peak at approximately 390°C with a frequency of 0.72 cps was also observed. Its characteristics were determined. The mechanisms observed could not be explained by any present model. (J.S.R.)

6853 (HSSTP-TR-2) THE EFFECT OF TESTING VARIABLES ON THE TRANSITION TEMPERATURE IN STEEL. Final Report. Loechel, L. W. (Martin Marietta Corp., Denver, Colo.). 29 Nov 1969. 139p. (MCR-69-189). Dep. NTIS.

Transition temperatures for drop-weight type specimens were determined for two steels, with specimens of various thicknesses and proportional-sized brittle weld beads. Transition temperatures were determined for fast and slow loading. Over the range of crack sizes investigated (0.08 to 0.67 in.) there was a 40°F increase in transition temperature for each factor of two increases in crack depth for the ASTM A533 grade B, class 1 steel and a 60°F increase for each factor of two increase in crack size for ASTM A516 Grade 55 steel. From the smallest size tested (3/8 in. plate, 0.08 in. cracks) of the A516 steel to the largest size of practical interest (12 in. plate, 2 in. crack for which the transition temperature was determined by analysis) the whole size effect is about 200°F for either steel. In both steels there was a small increase in transition temperature caused by increasing the loading rate by 40,000 : 1; namely 5 to 10°F for A533B steel and about 45°F for A516. Using measured strain tolerance values for A533B steel obtained from this investigation and fracture toughness values from the literature, an empirical formula was developed for strain tolerance as a function of fracture toughness, crack size, and plastic strain. The formula agrees with the fracture toughness data in the frangible region and with measured strain tolerance values in the tough region, thereby bridging the gap between linear elastic fracture mechanics and the concept of transition temperature. By means of the strain tolerance concept and the associated empirical formula, it is possible to calculate the effect of crack size on transition temperature (which agrees with observed values), and static-to-dynamic fracture toughness ratios can be estimated. In addition to the basic effects and concepts outlined above, additional useful information was obtained on suitability of Murex-Hardex-N weld rod, weld bead notch ductility, influence of heat-affected zone, strain-deflection relationships, the effect of multiple cracks, and the influence of pre-heat and post-heat in welding. Based on this information, certain modifications of the drop-weight test have been recommended. It is believed that these modifications will result in transition temperature values that are more in line with what is needed for conservative engineering practice. The drop-weight test provides safe design data only if the significance of all the variables affecting transition temperature are understood and properly taken into account. This investigation provides some of the information needed for this purpose, particularly information on crack size, loading rate, welding conditions, strain level, and crack dynamics. (auth)

6854 (MLM-1706) COMPATIBILITY OF $^{238}PuO_2$ WITH VARIOUS REFRACTORY METALS AND ALLOYS: INTERIM REPORT. Selle, J. E.; English, J. J.; Teaney, P. E.; McDougal, J. R. (Mound Lab., Miamisburg, Ohio). 23 Oct 1970. Contract AT(33-1)-Gen-53. 214p. Dep. NTIS.

Data accumulated on the compatibility of production grade $^{238}PuO_2$ with various refractory metals and alloys are presented and discussed. The materials discussed are tantalum, tantalum-10 wt % tungsten, T-111, T-222, niobium, molybdenum, TZM, molybdenum-50 wt % rhenium, rhenium, tungsten, tungsten-26 wt % rhenium,

hafnium, and zirconium. Test temperatures ranged from 1000 to 2500°C for time periods up to 532 days at the lower temperatures and up to 2000 hr at the higher temperatures. Consequences of the data obtained to date and future work are discussed. (auth)

6855 (NP-18565) ESTABLISHMENT OF A METHOD FOR CHECKING THE INCLUSION CONTENT OF STEELS. APPLICATION TO THE STEELS USED FOR THE CLADDING OF EL-4 FUEL ELEMENTS. Denis, Foure M. (Compagnie Pour l'Etude et la Realisation de Combustibles Atomiques, Romans-sur-Isere (France); Van Effenterre, Jean (Commissariat a l'Energie Atomique, Saclay (France), Centre d'Etudes Nucleaires). 28 Dec 1967. 68p. (In French). Dep. NTIS (U. S. Sales Only).

A method was developed to determine the inclusion content of fine steels. It was applied industrially to the testing of Z 8 CN Nb 18/10 steel recast under vacuum, used as cladding material for the fuel elements of the first EL 4 assemblies. The respective possibilities of adapting processes using visual comparison with standard micrographs and those based on model analysis are examined. A counting method using a perfected integrating eyepiece was developed for the purpose of checking the steel of EL 4 cladding. Some possible uses of micrometric grid integrating eye-pieces are mentioned. (France)

6856 (ORNL-TM-3055) HEAVY SECTION STEEL TECHNOLOGY PROGRAM. Whitman, G. D.; Witt, F. J. (Oak Ridge National Lab., Tenn.). Nov 1970. Contract W-7405-eng-26. 30p. (CONF-700935-1). Dep. NTIS.

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo.

The Heavy Section Steel Technology Program is an engineering investigation aimed at assessing the structural safety of primary pressure vessels for water-cooled nuclear reactor electric power plants. The main emphasis is placed on the effects of flaws, material inhomogeneities and discontinuities on the behavior of the vessels under normal operation and accident conditions. The overall program is briefly summarized and the more pertinent data are discussed. Fracture phenomena under the environmental conditions of interest and the effects of section thickness on the fracture behavior of large reactor vessels are being examined by a systematic progression of specimens up to the equivalent of full section thicknesses of 12 in. Plans have been made to test vessels of substantial thickness to failure in order to verify the adequacy of methods developed to predict fracture behavior. (auth)

6857 (ORNL-TM-3202) ANALYSIS OF CREEP DATA IN THE SELECTIONS OF MATERIALS FOR THERMIONIC CAPSULES. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). Nov 1970. Contract W-7405-eng-26. 11p. (CONF-691024-4). Dep. NTIS.

From IEEE Thermionic Conversion Specialist Conference, Carmel, Calif.

The creep-rupture properties of arc-melted tungsten, W–5% Re, W–26% Re, W–25% Re–30% Mo, and chemically vapor deposited (CVD) tungsten were studied with a view toward the selection of optimum materials for isotope containment for thermionic capsules. The times to 1, 2, and 5% creep are presented along with the time to rupture as a function of stress. The interaction of various failure criteria is discussed with reference to the selection of allowable stresses. (auth)

6858 (UJV-2436-M) MECHANICAL PROPERTIES OF URANIUM AND ITS ALLOYS BETWEEN -200°C AND 730°C. Saxl, I.; Otruba, J.; Kocik, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 91p. (In Czech). Dep. NTIS (U. S. Sales Only).

The tensile properties of polycrystalline reactor-grade and adjusted α-uranium have been investigated at −200 to 730°C. The temperature dependences of yield stress, ultimate tensile strength, fracture stress, total and homogeneous elongations, and reduction of area are given. A formal analysis of true stress, true strain diagrams and their temperature dependences is carried out. A more detailed study of high temperature deformations in reactor-grade uranium is made on the basis of strain rate cycling experiments. The mechanical tests are supplemented by optical metallographic examination of deformed specimens including the observation of deformed grain structure and observation of crack response and void morphology. Preliminary results concerning deformation processes of β-uranium are included. (auth)

6859 EFFECT OF TRAPPING ON THE RELEASE OF RECOIL INJECTED GASES FROM SOLIDS. Ong, A. Sy; Elleman, T. S. (North Carolina State Univ., Raleigh). Nucl. Instrum. Methods; 86: 117-25(1970).

Analytical solutions for the diffusion of fission-recoil-injected rare gas in the presence of homogeneously distributed traps in a solid were obtained. Predicted release curves for the diffusing gas can be readily generated for any value of the diffusion coefficient, trap concentration, trap retention time, and recoil range. Particular combinations of the diffusion parameters are shown to yield release curves which can be falsely interpreted if the existence of a trapping process is not recognized. (auth)

6860 HEAT CAPACITY OF α-CERIUM BETWEEN 2.5 AND 20°K. Panousis, N. T.; Gschneidner, K. A. Jr. (Ames Lab., Iowa). Solid State Commun.; 8: 1779-82(1 Nov 1970).

The low-temperature heat capacity of α-cerium, free from other allotropic modifications, was determined for the first time at standard pressures. The low-temperature data are represented by the equation: $C = 9.79\ T + (12/5)\ \pi^4\ R(T/117)^3$ where C is in mJ $mole^{-1}\ deg^{-1}$. (auth) (UK)

6861 YIELD STRESS OF NIOBIUM AND NIOBIUM–OXYGEN SOLID SOLUTIONS. Loomis, B. A.; Gerber, S. B. (Argonne National Lab., Ill.). Scr. Met.; 4: 921-4(Nov 1970).

The temperature dependence of the yield stress of high-purity niobium and niobium-oxygen single crystals was studied. Experimental results suggested that interstitial impurities contributed substantially to the strengthening of niobium at low temperatures. (G.M.C.)

6862 MEASUREMENT OF CONCENTRATION OF OXYGEN DISSOLVED IN TANTALUM. Anuchkin, A. M.; Volkov, A. K.; Kidin, I. N.; Rozhnova, T. M.; Shtremel, M. A. Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 1, 140-2(Jan 1970). (In Russian).

Concentrations of solid-solution Ta–O were measured in relation to the ratios of electric conductivity at room temperature and at 77°K. The dimensions or deformations of specimens did not influence the κ magnitude ($\kappa = \rho_{293°K}/\rho_{77°K}$). According to the Matthiessen law the $Z = (\kappa - 1)^{-1}$ was in linear relationship with C concentrations. Twelve sets with 206 specimens, containing 0.04 to 9.99% O were measured for κ, ρ and lattice α after annealing at 1800°C. For one phase, alloys with C ≤ 3.5 at. % 0 were found. (auth) (INIS)

6863 MECHANICAL PROPERTIES OF A COMBINED COPPER–NIOBIUM WIRE. Golovin, U. N.; Pletenetskii, G. E.; Somov, A. I.; Chornyi, O. V. (Physical-Technical Inst., Kharkov). Probl. Prochnosti; No. 4, 100-1(Apr 1970). (In Russian).

A multiple drawing method for various materials used to obtain a combined copper–niobium wire is described. The maximum ductility of the combined wire was 1.5 to 2 times the ductility and strength of copper wire. (auth) (INIS)

6864 EFFECT OF PROCESSING UPON PROPERTIES AND PHASE REACTIONS IN RENE 63 SHEET [HIGH-STRENGTH SUPERALLOY]. Barker., J. F. Cobalt. No. 41. 183-90(Dec. 1968).

The René 63 alloy studied is an experimental sheet alloy for high strength at temperatures up to 1800°F with weldability equivalent to that of René 41. Following rolling, the sheet was heat treated and its mechanical properties were evaluated; the results were correlated with microstructural data. Tabulated results show that decreasing finish-rolling temperature results in increased tensile ductilities at 1400°F. For sheet given 10% reductions/pass, finish rolling at 1900°F resulted in a 100% increase in ductility over sheet finish-rolled at 2100°F; the ductility improvement also correlates with longer soaking times in the 1900 to 2000°F range. Stress-rupture tests indicate that these properties are not impaired by rolling at lower temperature and may be improved. (Metals Abstr.)

6865 MASS SPECTROMETRIC INVESTIGATION OF THE THERMAL STABILITY AND VAPORIZATION OF LaPo, NdPo, GdPo, AND DyPo. Steiger, Ronald P.; Miles, Joseph C. (Monsanto Research Corp., Miamisburg, Ohio). J. Inorg. Nucl. Chem.; 32: 3469-70(Nov 1970).

These four rare earth monopolonides were prepared to define their thermal stability and vaporization processes. All the compounds vaporized incongruently and decomposed to the elements at the appearance temperature of polonium. The predominant process for the incongruent vaporization is $(RE)Po(s) \rightarrow (RE)Po_{1-x}(s) + xPo(g)$, where (RE) symbolizes the rare earth metal. (auth) (UK)

6866 PROPERTIES OF TRANSURANIC METALS. Mendelsshon, K. (Clarendon Lab., Oxford). Acta Phys. Pol.; A38: 459-66(Nov 1970).

A report is given on the properties of the actinide metals covering both equilibrium properties and the changes observed as the result of self-irradiation. Anomalies in the resistivity become more pronounced with increasing atomic number and reach a very striking appearance in the case of plutonium. Small anomalies have also been found in the specific heats of uranium and plutonium. A short account is given of the methods of investigation and the conclusion is reached that the anomalous behavior is due to some form of magnetic ordering. (auth)

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6867 DETERMINATION OF THERMODYNAMIC STABILITY OF THE Fe_2Ta INTERMETALLIC PHASE BY NON-STATIONARY E.M.F. MEASUREMENTS ON SOLID GALVANIC CHAINS. Barbi, G. B. (EURATOM–CCR, Ispra, Italy). J. Less-Common Metals; 22: 487-94(Dec 1970).

The open circuit voltage of the all-solid galvanic chain, $Pt|Fe + Fe_2Ta + Ta_2O_5|ThO_2(+LaO_{1.5})|Fe + Fe_{0.95}O|Pt$, and its decay after constant current polarization was measured and recorded. The decay curves were step-shaped, each rest-potential corresponding to well defined values of the oxygen chemical potential difference across the electrode/electrolyte interfaces. The trend of these curves was interpreted in terms of the rates of the following processes: interdiffusion of iron and tantalum between bulk and electrode interface and reaction of tantalum with oxygen impurities of the gas phase. On this basis, it is possible to define and determine the oxygen chemical potential in equilibrium with the ternary system $Fe + Fe_2Ta + Ta_2O_5$, corresponding to a rest-potential which is constant over a period of time and is reproducible. Taking into account analogous non-stationary experiments, carried out on a similar cell, in which the ternary system was replaced by the binary $Ta + Ta_2O_5$ system, the value of the standard molar free energy of formation of the iron-rich boundary intermetallic phase was calculated. Between 1070 and 1300°K the following relationship applies: $\Delta G^0_{f,Fe_2Ta} = -15.21 + 1.06 \times 10^{-3}T$ (°K) kcal/mole. (auth)

6868 CONTEMPORARY VIEW OF COBALT-BASE ALLOYS. Sims, Chester T. (General Electric Co., Schenectady, N. Y.). J. Metals; 21: No. 12, 27-42(Dec 1969).

Cobalt alloys have served outstandingly in gas turbine hot stage service. Their strong points are a flat rupture-parameter curve and excellent hot-corrosion resistance. Cobalt alloy systems enjoy considerable potential for service under still more severe conditions of temperature, stress, and environment. Cobalt alloys have a number of critical problem areas. These problems must be circumnavigated or solved in order for the alloys to realize their full potential. Some of the problems are: insufficient oxidation resistance, particularly above 2000°F; poor post-service tensile and rupture ductility up to intermediate temperatures; and low tensile yield properties in the general temperature range 500 to 1300°F. Incisive knowledge concerning the nature of these cobalt superalloy problems is scarce. Fundamental knowledge is rare, and much fundamental work needs to be undertaken. (auth)

6869 IMPROVEMENTS IN OR RELATING TO AUSTENITIC STAINLESS STEELS. Francis, John Michael (to United Kingdom Atomic Energy Authority). British Patent 1,210,064. 28 Oct 1970. Filed 19 Jan 1967.

The object is to specify alloys suitable for the fabrication of parts to be in contact with nuclear reactor coolants such as CO_2, water and steam, such alloys being modifications of those described in BP 905238 (Jan. 16, 1961), and having improved properties as regards oxidation resistance, anti-spalling, and induced activity of spalled oxides. Alloys of minimized Mn content show improved oxidation resistance in reactor coolants, some tests of which are described. It was also found that reducing the Co impurity to 0.005 or even 0.001 wt % reduces hazards due to spalled oxides, and that for similar reasons Ta should not exceed 0.025 wt %. Addition of Y or Gd (0.025 to 1 wt %) also reduces the spalling. In order to produce Nb-stabilized alloys with such a low Ta content it is probably necessary to employ pure Nb as alloying addition instead of ferro-Nb. Such alloys are described. (UK)

6870 THERMAL PROPERTIES OF MOLYBDENUM AT HIGH TEMPERATURES. Makarenko, I. N.; Trukhanova, L. N.; Filippov, L. P. (Inst. of Crystallography, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 416-18(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 445-7(Mar-Apr 1970).

The method of alternating induction heating was used on monocrystalline and polycrystalline Mo samples. Electric resistivity, monochromatic and total coefficients of blackness of radiation, thermal diffusivity, heat capacity, and thermal conductivity were measured at 1100 to 2400°K. (D.L.C.)

6871 ENTHALPY OF A TUNGSTEN–MOLYBDENUM ALLOY IN THE TEMPERATURE RANGE 1400 TO 3000°K. Chekhovskoi, V. Ya.; Tarasov, V. D.; Zhukova, I. A. (Inst. of High Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 422(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 449(Mar-Apr 1970).

The enthalpy of a W–20 wt % Mo alloy was measured at 1400 to 3000°K with an accuracy of 0.5 to 0.7% up to 2300°K and 1 to 1.3% above 2300°K. (D.L.C.)

6872 ANISOTROPY OF THE PLASTIC PROPERTIES OF REFRACTORY METALS. Palme, R. Metall; 24: 719-22 (Jul 1970). (In German).

The texture of refractory metals and anisotropy of their mechanical properties are discussed. The anisotropy of plates and sheets of these metals, which is related to strength, is designated as plastic anisotropy. The detection of anisotropy by hardness measurements is described. Examples of the effects of this plastic anisotropy on machining of these metals are considered. (M.C.G.)

6873 PURE COBALT ALLOYS WITH ADDITIONS OF CARBON, TUNGSTEN, AND TITANIUM. PART II. MALLEABILITY, STRUCTURE INVESTIGATIONS, AND PHYSICAL PROPERTIES OF BINARY AND TERNARY ALLOYS. Ruediger, O.; Hoffmann, A. (Zentralinstitut fuer Forschung und Entwicklung, Essen). Metall; 24: 723-34(Jul 1970). (In German).

Pure binary and ternary cobalt alloys with additions of C, W, and Ti were melted in a vacuum-induction oven by the carbon reduction method and forged at 1150°C. Structure formation and mechanical properties were studied. (M.C.G.)

6874 PHYSICAL PROPERTIES OF THE SINTERED MOLYBDENUM ALLOY TZM. Eck, R. Metall; 24: 743-7(Jul 1970). (In German).

Mechanical properties and uses of TZM alloy are discussed. Dependence of hardness and structure on the annealing time and temperature is shown. (M.C.G.)

6875 PROPERTIES AS HIGH-TEMPERATURE MATERIALS OF THE REFRACTORY METALS TITANIUM, NIOBIUM, TANTALUM, MOLYBDENUM, AND COBALT, AND OF THEIR ALLOYS. PART II. Wiedemann, K. H. (Eidgenoessische Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Metall; 24: 748-54 (Jul 1970). (In German).

The physical and mechanical properties of Nb, Ta, Mo, Co, and their alloys are discussed. Tensile properties vs temperature or vs load duration were compared. 89 references. (M.C.G.)

6876 ^{85}Kr RELEASE DURING THE OXIDATION AND SELF-HEATING OF IRRADIATED URANIUM IN AIR. Hilton, D. A. (Berkeley Nuclear Labs., Eng.). J. Nucl. Mater.; 37: 286-94 (Dec 1970).

The behavior of the fission gas ^{85}Kr was studied during the oxidation of irradiated uranium in air. Over the temperature range 220 to 320°C there was a direct proportionality between the extent of isothermal oxidation and the amount of ^{85}Kr released. Above 300°C the irradiated metal could self heat and although well defined ignitions did not occur a thermal cycling reaction was observed, which with unirradiated uranium was initiated at a temperature at least 200°C higher. During thermal cycling the ^{85}Kr release curve followed with considerable sensitivity the irradiated metal temperature curve. The degree of self heating was insufficient for fission gas bubble growth to play a significant role during the oxidation and it is concluded that the solid fission product concentration in the oxide and oxide stoichiometry are important parameters in the initiation and continuation of the temperature cycling reactions. (auth)

Structure and Phase Studies

Refer also to abstracts 6484, 6494, 6907, and 6910.

6877 (AAEC/E–204) CRYSTALLOGRAPHIC TECHNIQUES AND DATA FOR TRANSMISSION ELECTRON MICROSCOPY OF ZIRCONIUM. Jostsons, A.; Napier, J. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1970. 47p. Dep. NTIS (U. S. Sales Only).

The crystallography of hexagonal close packed metals is discussed briefly in terms of the four-axis hexagonal basis and the Miller–Bravais notation. Electron diffraction problems are treated with reference to the four-axis hexagonal reciprocal lattice rather than the more usual three-axis hexagonal system. Using these concepts, analysis of electron-diffraction spot and Kikuchi patterns is illustrated and applied to orientation and dislocation Burgers vector determinations. Computed values of interplanar spacings, interplanar angles, angles between directions, and extinction distances for zirconium are listed. (auth) (Australia)

6878 (UCRL–18818(Rev.)) CARBON REPLICA PREPARATION FOR ELECTRON MICROSCOPY. Glba, Walter T.; Muller, Rolf H. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug 1970. Contract W-7405-eng-48. 20p. Dep. NTIS.

Detailed procedures are given for the preparation of two-step carbon replicas of metal surfaces for examination by transmis-

sion electron microscopy. The technique employs a plastic replicating film and is particularly suited for metal surfaces resulting from electrochemical dissolution. (auth)

Radiation Effects

6879 (CEA-CONF-1523) IRRADIATION DAMAGE FROM PILE NEUTRONS. Cance, M.; Genthon, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 9 Mar 1970. 7p. (In French). (DPE/SPE-701182; CONF-700326-1). Dep. CFSTI (U. S. Sales Only).

From Working Group of the AIEA on the Measurement of Reactor Radiations, Grenoble, France.

The irradiation damage to graphite and steel from reactor neutrons is considered. The definition and measurement of the number of displaced atoms in graphite are discussed. The theoretical and experimental study planned for the determination of the effect of the duration of irradiation is outlined. The effects of reactor neutrons on the mechanical properties and swelling of steel are described. (J.S.R.)

6880 (CEA-N-1383) NOTES ABOUT NEUTRON RADIATION INDUCED SWELLING IN STAINLESS STEELS. Barre, Bertrand (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1970. 95p. (In French). Dep. NTIS (U. S. Sales Only).

In order to update the paper CEA-N-1064, notes are presented, summing up the main articles published about fast reactor radio-induced swelling in stainless steel. Information is included on measurement of reactor material swelling, theory of swelling, swelling of pure metals, irradiation by heavy ions, and simulation of defects on computers. (auth) (France)

6881 (GEAP-13571) EVALUATION OF PHYSICAL AND MECHANICAL PROPERTIES OF TYPE-304 STAINLESS STEEL AFTER IRRADIATION TO 3.9 x 10^{22} n/cm^2 TOTAL FLUENCE. Busboom, H. J.; Asamoto, R. R. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Feb 1970. Contract AT(04-3)-189. 34p. Dep. NTIS.

A program has been carried out to examine physical and mechanical properties of structural members made from Type 304 stainless steel of EBR-II subassembly XG05. At the time of its removal from EBR-II, this subassembly had reached a peak fluence of 3.9×10^{22} n/cm^2, total at maximum temperatures of 910°F. The results, which include measurements of mechanical properties, density, and helium contents, suggest that the degradation of properties is not disabling to the reactor components at the fluence levels indicated above. (auth)

6882 (JAERI-Memo-4124) PLASTIC DEFORMATION OF ZONE-REFINED TUNGSTEN BETWEEN 4.2 AND 300°K. Oku, Tatsuo; Galligan, J. M. (Japan Atomic Energy Research Inst., Tokyo). Aug 1970. 17p. (CONF-700819-8). Dep. NTIS (U. S. Sales Only).

From 2nd International Conference on the Strength of Metals and Alloys, Pacific Grove, Calif.

The macroscopic deformation behavior of tungsten crystals of various purities was studied. These studies show quite clearly that a fair portion, ~30%, of the temperature dependence of the critical resolved shear stress is impurity dependent. For the crystals used in the present study, with resistivity ratios between ~2000 and 20,000, increasing purification not only decreased the temperature dependence of the critical resolved shear stress, (C.R.S.S.), but decreased the C.R.S.S. at 4°K, contrary to common assertions. Another aspect of this study was concerned with the influence of various types and concentrations of defects, introduced by neutron irradiation, upon the temperature dependence of the C.R.S.S. The type of defect introduced was varied from primarily random distributions of point defects (thermal-neutron irradiation with ratio of slow to fast neutrons >10^2) to large damage zones and mixtures of damage zones and loops introduced by fast neutrons. In this way the specific influence of defects of various sizes could be obtained. For point defects (thermal-neutron irradiation) the most pronounced change in the temperature dependence of the C.R.S.S. occurs between 4.2 and 20°K. In the case of fast neutron irradiation (defect clusters), the most marked change in the temperature dependence of the C.R.S.S. occurs between 4.2 and 80°K. A comparison of these results with various models of the temperature dependence of the C.R.S.S. in bcc metals is given. (auth) (Japan)

6883 (JAERI-Memo-4149) ELECTRON MICROSCOPE STUDY OF NEUTRON IRRADIATION DAMAGE IN VANADIUM. Katano, Yoshio; Fukaya, Kiyoshi (Japan Atomic Energy Research Inst., Tokyo). Sep 1970. 30p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The technique of transmission electron microscopy was used to study neutron irradiation damage and its behavior on annealing in vanadium. Foils were irradiated at 140 and 400°C to fast neutron doses of 1×10^{20}/cm^2 and 5×10^{19}/cm^2, respectively. Point-defect clusters of ~85 Å in diameter with ~1×10^{16}/cm^3 in density were observed in the specimen irradiated at 140°C. On annealing, the clusters grew as dislocation loops and the average diameter of the loop increased with decreasing in their density. In the specimen annealed for 1 hr at 560°C, the loops of 9×10^{14}/cm^3 in density had an average diameter of 370 Å and are identified as faulted vacancy loops lying upon the {111} planes with a ½⟨111⟩ Burgers vector normal to the loop. The loops interacted on each other along dislocation lines upon heating at higher temperature (680°C) and disappeared finally (at 800°C). In the specimen irradiated at 400°C, faulted ½⟨111⟩, {111} loops were observed of ~250 Å diameter with 2.3×10^{13}/cm^3 in density and most of the loops (~80%) were identified as interstitial in character; the others are vacancy loops. They seemed to disappear with annealing for 1 hr at 310°C, and small loops (~90 Å) of high density (9×10^{14}/cm^3) appeared in place of the faulted loops. On increasing annealing temperature, the diameter of the small loops increased and their density decreased. The loops observed in the specimen heater 1 hr at 500°C had an average diameter of ~160 Å and density of 2.8×10^{14}/cm^3. They were analyzed to be perfect loops lying on {110} planes with Burgers vector of ½⟨111⟩. Here again, ratio of the vacancy loops to the interstitial was about 0.3. On further annealing, the loops disappeared with decreasing diameter and density. (auth) (Japan)

6884 (WHAN-FR-15) NOTE ON THE INTERDEPENDENCY OF SWELLING, VOID DIAMETER AND VOID NUMBER DENSITY IN ANNEALED AISI TYPE 304 STAINLESS STEEL. Straalsund, J. L.; Bates, J. F. (WADCO Corp., Richland, Wash.). Oct 1970. Contract AT(45-1)-2170. 17p. Dep. NTIS.

This note describes the development of a set of three mutually consistent empirical equations describing void number density, void diameter, and swelling (or void volume) as a function of fluence and temperature. The equation for swelling reflects trends consistent with available transmission electron microscopy data. (auth)

6885 RADIATION EFFECTS ON THE PROPERTIES OF HIGH-ALLOY STEEL AND ALLOY WELD SEAMS. Votinov, S. N.; Kazennov, Yu. I.; Agapova, N. P.; (and others). Svar. Proizv.; No. 3, 4-6(Mar 1970). (In Russian).

Mechanical properties of specimens cut from the welded seams of steel (00Cr16N15M3B, 0Cr16N15M3B, 0Cr20M40B, and ICr13M2BFR) and irradiated with 2.8×10^2 neutrons/cm^2 and 4.3×10^{21} neutrons/cm (E ≥ 1 MeV) at 1000°C temperature were studied. Tests were carried out in tensile test machines at 20, 350, and 650°C in air. (auth) (INIS)

6886 ABSENCE OF VOIDS IN NEUTRON IRRADIATED SPUTTERED NICKEL. Guthrie, G. L.; Mastel, B.; Kissinger, H. E.; Bradley, E. R. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater.; 37: 343-4(Dec 1970).

Postirradiation examination of a sputtered nickel sample by transmission electron microscopy showed a complete absence of voids although numerous voids were found in a control sample of annealed high-purity nickel irradiated under identical conditions. The irradiation was performed at 400°C and the total fluence was 2.2×10^{19} n/cm^2 (E > 1 MeV). Possible mechanisms for void suppression in the sputtered nickel foil are proposed. (G.M.C.)

Ceramics and Cermets

Refer also to abstracts 6399 and 6827.

6887 (BMI-1886) PROGRESS ON DEVELOPMENT OF FUELS AND TECHNOLOGY FOR ADVANCED REACTORS DURING JULY 1969-JUNE 1970. Annual Report. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Jul 1970. Contract W-7405-eng-92. 252p. Dep. NTIS.

Research and development on reactor fuels and materials is presented in three sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 6888 through 6890.

6888 (BMI-1886, Sect. A) URANIUM-PLUTONIUM NITRIDE FUELS FOR LMFBR APPLICATIONS. (Battelle Memorial Inst., Columbus, Ohio). 88p.

From Progress on development of fuels and technology for advanced reactors during July 1969-June 1970.

Research and development progress is summarized on thermodynamic properties of PuN and UN, compatibility of PuN and UN

with cladding and coolants, analyses of Na capsule bonds, diffusion in nitrides, Na bonding of nitride fuels, fabrication of PuN–UN fuels, radiation effects on nitride fuels, preparation of EBR-II fuels, TREAT testing, and physics support for nitride fuels program. (J.R.D.)

6889 (BMI-1886, Sect. B) TECHNOLOGY OF NUCLEAR FUELS FOR ADVANCED FAST REACTORS. (Battelle Memorial Inst., Columbus, Ohio). 116p.

From Progress on development of fuels and technology for advanced reactors during July 1969–June 1970.

Research and development progress is summarized on radiation effects testing of oxide fuels, W-UO_2 cermets, nitride fuels, and carbide fuels. Results of work are also included on fission gas diffusion, fission gas bubble characteristics, creep of fuels and cladding materials, fuel sublimation, solid bonding, transducer development, and neutron radiography. (J.R.D.)

6890 (BMI-1886, Sect. C) CREEP OF REACTOR FUEL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 48p.

From Progress on development of fuels and technology for advanced reactors during July 1969–June 1970.

Research and development progress is reported on design and operation of in-pile creep capsules, mechanical and thermal analyses of oxide fuels, fabrication of fuel creep specimens, compressive creep testing of fuels, and mechanisms of creep in oxide fuels. (J.R.D.)

Corrosion and Erosion

Refer also to abstract 8067.

6891 (EURFNR-811) CONTACT EFFECTS BETWEEN MOLTEN UO_2 AND SODIUM AND MOLTEN UO_2 AND WATER. Amblard, M.; Semeria, R.; Vernier, P.; Gouzy, A.; Najuc, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translation of report T. T. No. 96. 61p. Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

Bringing molten UO_2 into contact with sodium at 200 and 400°C revealed a very fine UO_2 dispersion and considerable dynamic overpressure in the sodium. UO_2–water contact (temperature 20°C and atmospheric pressure) led to the formation of long hollow tubes of UO_2. In both the above cases, hollow drops of UO_2 which trap the coolant are formed. The different properties of the two coolants, in particular the heat conductivity, heat capacity and boiling temperature, lead to a violent burst in the case of the sodium and to plastic deformation of the fuel in the case of the water. Fusion manipulation of a cylinder of UO_2 by the Joule effect, surrounded by stainless steel cladding cooled by hot static water under pressure, showed that the clad was pierced by the molten UO_2 and the fuel was able to disperse in the coolant. (auth)

Preparation and Fabrication

Refer also to abstracts 6295, 6392, and 6839.

6892 (DP-Report-430) KEMA SOL-GEL PROCESS. Project DRAGON. Van Der Plas, Th.; Kanij, J. B. W.; Noothout, A. J.; Hermans, M. E. A. (Atomic Energy Establishment, Winfrith (England)). May 1966. 10p. (CONF-660318-10). Dep. NTIS.

From Dragon Contractors' Research and Development Symposium, Harwell, England.

The known variants of sol-gel processes are discussed along with the processes developed at KEMA. The sol preparation step consists of a peptization of thorium hydroxide by nitric acid or uranyl nitrate. The sol is dispersed in the form of droplets in an organic liquid as an emulsion of the water-in-oil type. Gelation is effected externally by a process in which ammonia is introduced from outside the sol droplet, and by internal gelation, where ammonia is produced homogeneously throughout the drop. The first method is effective for particles up to 100 μm diameter. A few properties of oxide products are given. (auth)

6893 (WHAN-FR-7) ASPECTS OF DENSITY MANIPULATION IN FABRICATION OF MIXED (U,Pu) OXIDE FUEL PELLETS. Barr, M. J. (WADCO Corp., Richland, Wash.). Oct 1970. Contract AT(45-1)-2170. 50p. Dep. NTIS.

Density control in mixed oxide [$(U,Pu)O_2$] fuel pellets can be achieved by several ceramic processing techniques. Binder-lubricant (hydrocarbon) additions, calcination of blended oxides, and ball-milling parameters were evaluated with respect to degree of density change and modification of microstructure. Binder-lubricants evaluated included Carbowax, Sterotex, methyl cellulose, polyvinyl alcohol, and Acrawax. Calcination of blended oxides was done in air and in nitrogen at temperatures up to 1000°C. Mixing-grinding experiments evaluated the effect of time, techniques, and grinding media on density, homogeneity, and impurity level. (auth)

6894 TECHNIQUE FOR THE PREPARATION OF THIN FILMS FOR TRANSMISSION ELECTRON MICROSCOPY FROM HIGHLY IRRADIATED URANIUM DIOXIDE FUEL ELEMENTS. Bainbridge, John Evelyn (Atomic Energy Research Establishment, Harwell, Eng.). Prakt. Metallog.; 7: 561-71(Oct 1970). (In English and German).

Techniques were developed for the preparation of thin films suitable for transmission electron microscopy from highly irradiated, cracked uranium dioxide fuel elements. The essential feature of the various stages of the technique (impregnation, slicing, trepanning, and thinning) was that the number and complexity of the handling operations were reduced to a minimum. In the thinning operation this was achieved by electropolishing with a reversible polarity double jet electrolyte process which eliminated the need for mechanical contact. (auth)

6895 EFFECTS OF THE METHOD OF PRODUCTION OF TiC AND ZrC SPECIMENS ON THEIR HIGH-TEMPERATURE PROPERTIES. Ordan'yan, S. S.; Drozdetskaya, G. V. (Leningrad Inst. of Tech.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 63-7(Aug 1970). (In Russian).

The strength of TiC and ZrC samples with different porosity was studied at 300 to 3000°K. The highest strength shown is at 0.6 to 0.7 T_{melt}, the appearance of which is connected with transition of the materials at greater than 0.5 T_{melt} to a viscous-brittle state. Effects of sample production methods on TiC and ZrC and their mechanical properties were determined. (auth)

6896 FIBERING CERAMICS BY MECHANICAL DEFORMATION. Jech, R. W.; Weeton, J. W.; Signorelli, R. A. (Lewis Research Center, Cleveland). Amer. Ceram. Soc. Bull.; 49: 983-7 (Nov 1970).

Preparation of ceramic fibers by the deformation of ceramic particles in a tungsten matrix is described. Irregularly shaped powders or spheres of Al_2O_3, ZrO_2, HfO_2, and ThO_2 were the starting materials. Deformation was carried out by extrusion at 3600 to 4000°F. Fibers of ZrO_2, HfO_2, and ThO_2 were produced. Some had aspect ratios (length to diameter) as high as 80. Re-extrusion further reduced the cross-section of the fibers with a commensurate increase in length. Aspect ratios of ZrO_2 fibers were as high as 640. Fibers removed from the tungsten were examined for internal grain size and grain orientation by x-ray diffraction. Aspect ratios were compared to predicted values based upon reduction ratio. (auth)

6897 TRAPPING OF ^{131}I DURING REMOTE METALLOGRAPHIC OPERATIONS. Cochran, F. L. (Gulf General Atomic Inc., San Diego, Calif.). J. Nucl. Mater.; 37: 347-8(Dec 1970).

A method for trapping ^{131}I during the postirradiation preparation of fuel particles for metallographic examination is given. The trapping occurred during the initial grinding of the fuel particles by using an $AgNO_3$ solution as the coolant-lubricant. (G.M.C.)

Properties Evaluations

Refer also to abstracts 6322, 6854, 6859, and 8138.

6898 (ALO-(2510)-10) SILICON GERMANIUM THERMOELECTRIC MATERIALS AND MODULE DEVELOPMENT PROGRAM. 10th Quarterly Report, April 1, 1970–June 30, 1970. (RCA, Harrison, N. J.). Contract AT(29-2)-2510. 78p. Dep. NTIS.

Research and development are reported on SiGe thermoelectric materials technology, Air-Vac module development, and cascaded converter development. During the reporting period the 24-thermocouple test panel P-1 (24A) was fabricated, assembled and instrumented for performance testing. This panel simulates the geometry, materials, and environment of a MHW-type converter operating under single stage conditions. Fabrication of the foil insulation for panel CA-3 was also completed, and fabrication of the thermocouples was initiated. This panel simulates conditions of a MHW-type SiGe converter operating under cascade conditions. The performance of shock and vibration testing of the zirconia felt-insulated 5-watt converter (C3Z) was continued with no change in operating characteristics noted as a result of these tests. A rerun of performance mapping on the rebuilt C-4 converter was conducted with essentially the same B.O.L. performance noted as in the earlier run. An excess of 2100 hours of stability testing at 1100°C was accumulated on the C-4 converter with no degradation attributable to leakage resistance in the thermopile. The

accumulation of substantial additional thermal conductivity data is reported on SiMo and SiGe over a range of compositions from tests run at Sandia, BMI, and RCA. The completion and compilation of the developed analytical approach towards cascading SiGe and PbTe stages is also reported. (auth)

6899 (GA-9975) RESEARCH ON GRAPHITE. Three-Year Summary Report, May 15, 1967-May 14, 1970. Engle, G. B.; Price, R. J.; Bokros, J. C.; White, J. L. (Gulf General Atomic, Inc., San Diego, Calif.). 1 Jun 1970. Contract AT(04-3)-167. 117p. Dep. NTIS.

Research directed toward an understanding of the relationships between the properties, microstructure, and irradiation behavior of the various carbonaceous and graphitic materials required for use in high-temperature reactors of advanced design and thus to provide a basis for substantial improvements in fabrication and the service behavior of these materials is summarized. The materials studied during the course of the work were composed of carbon in a wide variety of structures, ranging from nearly amorphous forms to highly crystalline states. The experimental work consisted of studies on carbonization, catalytic graphitization, characterization of microstructures, and irradiation of the various materials. The research efforts were directed toward defining the structure of the various materials, learning the relations between structure and properties relevant to reactor applications, and evaluating methods for the preparation of new or modified structures with improved properties. Topical reports have been completed to cover the work reported in all sections except those on highly oriented graphites and on thermal conductivity and irradiation creep of artificial graphites. The titles of these reports are listed. (J.R.D.)

6900 (ORNL-4598) BIBLIOGRAPHY WITH ABSTRACTS ON CARBON-CARBON AND ASSOCIATED COMPOSITES. O'Hara, F. M. Jr.; Cook, J. L. (Oak Ridge National Lab., Tenn.). Oct 1970. Contract W-7405-eng-26. 30p. Dep. NTIS.

The results of a search of Scientific and Technical Aerospace Reports and International Aerospace Abstracts for the period 1965 to July 1970 are presented. The terms searched under were ablation, ablative material, ablative nose cones, carbon, composite materials, composite structures, graphite, heat shielding, nose cones, reentry shielding, reentry vehicles, and rocket nose cones. Literature on carbon-carbon, carbon-graphite, and graphite-graphite composites was sought primarily, but literature on metal-matrix/carbon-reinforced composites and metallic-carbide composites with either a carbon, graphite, or metal matrix was noted, also. These have been grouped under the headings "Carbon-Carbon Composites," "Metallic-Carbide Composites," and "Metal-Matrix Composites." No interest was taken in any composites incorporating glass or plastics. The entries are arranged according to index number assigned by the source in which the abstract was found: IAA ("A" numbers) and STAR ("N" numbers). Reference to and verification of these sources can be made through these index numbers. A number of abstracts were used from the Defense Ceramic Information Center's Ceramic Awareness Bulletin; these appear under the subheading "From CAB." Entries for which abstracts were found in none of these sources appear under "Other." (auth)

6901 INTERACTION OF ZIRCONIUM DIOXIDE WITH CARBON. Elyutin, V. P.; Pavlov, Yu. A.; Manukhin, K. V.; Melekhin, V. F. Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 1, 5-8(Jan 1970). (In Russian).

Reactions of ZrO_2 with carbon were studied at 2200 to 2600°C with specimens distributed in close contact. Thermogravimetric analysis produced the curves describing the reaction process on the surface of oxidized specimens in the presence of carbon and also the processes in the absence of carbon. Changes in total losses in the oxidized specimen and in carbon in the contact zone were measured as a function of the time of the isothermal time lag. The loss of mass was used for calculating the thickness of the carbide layer that was formed as a function of the time lag and the coefficient of carbon diffusion into ZrO_2 at various temperatures. It was postulated that the reaction was mainly based on the oxide transition into the gas phase, which was followed by deposition of ZrO on carbon. After formation of the carbide coating the interaction process was limited by carbon diffusion into the ZrC layer. (tr-auth) (INIS)

6902 STABILITIES OF THE LOWER OXIDES OF THE RARE EARTHS. McCarthy, J.; White, W. B. (Pennsylvania State Univ., University Park). J. Less-Common Metals; 22: 409-17(Dec 1970).

The stabilities of the lower oxides of samarium, europium, and ytterbium are discussed. An extensive review of the methods of preparing the lower oxides and their degree of success is presented. Thermodynamic calculations are performed which indicate the great stability of EuO, SmO, and YbO are not stable phases at high temperatures and all high temperature attempts to prepare them have failed. Thermodynamic considerations indicate that YbO may be stable at low temperatures and recent results indicate that it may be able to be prepared under such conditions. Crystal chemical stabilization offers the greatest hope of preparing Yb^{2+} and Sm^{2+} in oxides. Recent thermodynamic data on the europium oxides are utilized to calculate stability among these oxides as a function of f_{O_2} and T. Based on these calculations and recent literature, a not-impossible T-X phase diagram for $Eu-Eu_2O_3$ is constructed. Suggestions for further work are given throughout. (auth)

6903 PLASTIC DEFORMATION IN HAFNIUM CARBIDE. Lewis, D.; Porter, L. J. (Univ. of Surrey, Guildford, Eng.). J. Less-Common Metals; 22: 439-44(Dec 1970).

Hafnium carbide could be plastically deformed by ball-milling and exhibited marked anisotropic behavior when deformed ⟨100⟩ directions were relatively plastic compared with more brittle behavior in the ⟨110⟩ directions, where cleavage occurred. The annealing curves suggested a recovery and recrystallization process, as in metals. The hafnium carbide lattice was remarkably stable at high temperatures compared with other transition metal carbides, microstrains annealing out at nearly double the temperature of tungsten carbide. Ball-milling at various temperatures showed an increase in deformation with temperature. (auth)

6904 YOUNG'S MODULUS AND THE THERMAL EXPANSION OF ^{6}LiD FROM 20 TO 300°K. Eash, D. T. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater.; 37: 358-60(Dec 1970).

Thermal expansion measurements were obtained from three specimens of ^{6}LiD over the temperature range 20 to 300°K. Polycrystalline specimens 0.635 cm in diameter by 10.160 cm long were used. The lithium was nominally 95% enriched in ^{6}Li. Young's modulus was also obtained over the same temperature interval. (auth)

6905 ELASTIC MODULI AND INTERNAL FRICTION OF SOME URANIUM CERAMICS. Hall, A. R. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 37: 314-23(Dec 1970).

An apparatus was developed in which the resonant frequencies of thin prismatic bars could be measured in vacuum over a wide temperature range. This was used to measure properties of the following materials: hypostoichiometric UC, Young's modulus, shear modulus, and internal friction to 725°C; hyperstoichiometric UC, Young's modulus and internal friction to 1350°C; stoichiometric UO_2, Young's modulus, shear modulus, and internal friction to 1250°C; and UN, Young's modulus and internal friction to 1420°C. It is concluded that the temperatures at which the Young's modulus-temperature curves begin to deviate from linearity correspond to the lowest temperatures at which plastic deformation can take place. The values for the materials tested are: hypostoichiometric UC, 600°C; hyperstoichiometric UC, 1000°C; $UO_{2.00}$, 1000°C; and UN, 1200°C. It is suggested that the peaks found in the internal friction spectra are attributable to grain boundary relaxation processes. (auth)

6906 REACTIVITY OF GRAPHITE TO OXYGEN: THE EFFECT OF IMPURITIES ADDED AFTER NEUTRON-IRRADIATION. Harker, H.; Horsley, J. B.; Robson, D. (Univ. of Newcastle upon Tyne, Eng.). J. Nucl. Mater.; 37: 331-9(Dec 1970).

Moderator graphite, neutron-bombarded in an atmosphere of carbon dioxide, showed a higher reactivity than virgin material to molecular oxygen, though the difference was rather a small one. However, accelerating impurities such as ferric nitrate or potassium, deliberately added after irradiation, had a considerable influence, especially in specimens containing large numbers of bombardment-induced defects; the increased combustion rate was due almost entirely to a higher rate of production of carbon dioxide, the formation of carbon monoxide remaining virtually unaltered. A co-operative effect is believed to occur as a consequence of metal atoms becoming incorporated into the solid at lattice imperfections. This is borne out by the finding that the uptake of alkali metals, introduced either electrochemically or from the vapor phase, was significantly greater after irradiation. The large electron spin resonance signal, produced in the graphite by neutron-bombardment, decayed progressively as potassium entered the structure. In contrast to the behavior previously reported for bromine, intercalation of the alkali metal could still be detected after irradiation in vacuum rather than in carbon dioxide. (auth)

XUM

Structure and Phase Studies

6907 (SRO-552-4) QUANTITATIVE DETERMINATION OF THE STRUCTURE: PROPERTY RELATIONSHIPS IN NUCLEAR FUEL ELEMENT MATERIALS. Annual Progress Report, June 15, 1969–June 14, 1970. Rhines, F. N.; DeHoff, R. T.; Hench, L. L. (Florida Univ., Gainesville. Engineering and Industrial Experiment Station). Sep 1970. Contract AT(38-1)-552. 58p. Dep. NTIS.

Research directed toward the establishment of quantitative relationships between microstructure and properties in nuclear fuel element materials is reported. The materials and equipment necessary for carrying out this program have been assembled, including an image analyzing computer, thermal conductivity device, gas permeability apparatus, and creep furnaces. Selected sinterings from the two powders have been prepared and tested in these devices, and all have been demonstrated to be operational. Gas permeability of nickel sinterings has been found to depend upon porosity in proportion to the genus (or connectivity) of the pore network. Preliminary information on the dependence of this relationship upon particle size indicates that the genus is not the only geometric factor involved in governing gas permeability. Studies in the quantitative microscopy of fractures have yielded a new relationship which permits the estimation of the area fraction of solid phase in a fracture surface. This procedure has been successfully applied to predicting the fracture and yield strengths of porous copper sinterings. (auth)

6908 PHYSICOCHEMICAL PROPERTIES AND STRUCTURE OF SIMPLE AND COMPLEX HYDRIDES OF TRANSITION METALS. Samsonov, G. V.; Morozov, V. V. (Inst. of Problems in Studies of Solids, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 55-62(Aug 1970). (In Russian).

A survey is presented of the current concepts of the structure of transient metal hydrides. The data are given on physicochemical properties of hydrides of metals from the III to IV groups. A model is suggested according to which the metal atoms in hydrides allow non-localized valent electrons to form s^2-configurations of hydrogen atoms. The ternary hydride phases of Me–C–H and Me–N–H type are considered. (auth)

6909 COMPOSITION OF PHASES IN NIOBIUM–NITROGEN AND NIOBIUM–ZIRCONIUM–NITROGEN ALLOYS. Savage, H.; Altstetter, C. (Univ. of Illinois, Urbana). Contract AT(11-1-1198. J. Less-Common Metals; 22: 399-407(Dec 1970).

Microconstituents were examined in a niobium-2 wt % nitrogen alloy after equilibration at 800, 1000, and 1200°C, and in a Nb–0.86 wt % Zr–3.6 wt % N alloy after quenching. An electron beam microprobe analyzer was used to make a quantitative analysis for all three elements. The nitride in equilibrium with the binary solid solution was slightly hypostoichiometric Nb_2N for all three temperatures. In the ternary alloy, the zirconium was found to segregate to the nitride formed at high temperatures, but not to the nitride formed during cooling. Depletion of zirconium from the surface was significant at 1800°C. (auth)

6910 CRYSTAL STRUCTURES OF Am–Sb, Am–Se, AND Am–Te ALLOYS NEAR THE EQUIATOMIC COMPOSITION. Mitchell, A. W.; Lam, D. J. (Argonne National Lab., Ill.). J. Nucl. Mater.; 37: 349-52(Dec 1970).

The lattice parameters, calculated and observed d-spacings, and the calculated and observed line intensities for the compounds AmSb, Am_3Se_4, and Am_3Te_4 are reported. (auth)

6911 PHASE RELATIONS IN THE URANIUM–CARBON–OXYGEN SYSTEM AT 1573°K. Javed, N. A. (Pakistan Atomic Energy Commission, Karachi). J. Nucl. Mater.; 37: 353-4(Dec 1970).

On the basis of experimental results from x-ray diffraction, metallographic, and chemical analyses a ternary isothermal section is proposed for the C–O–U system at 1573°K. (G.M.C.)

6912 INVESTIGATION IN THE AMERICIUM OXIDE SYSTEM. Sari, C.; Zamorani, E. (Institut fuer Transurane, Karlsruhe, Ger.). J. Nucl. Mater.; 37: 324-30(Dec 1970).

The americium-oxygen system was investigated between room temperature and 1400°C using DTA and ceramographic procedures. The results together with the published x-ray data of Chikalla and Eyring were used to draw a low temperature partial Am–O phase diagram. At temperatures above 1020°C and for $1.7 \leq O/Am \leq 2.0$ an oxygen deficient fcc single phase AmO_{2-x} existed. At room temperature the compound $AmO_{1.98}$ was in equilibrium with a bcc phase of the C-type rare earth with approximate composition $AmO_{1.53}$. At temperatures higher than 350°C the low temperature bcc phase took up additional oxygen and extended into a region of composition $1.62 \leq O/Am \leq 1.68$. For higher O/Am ratios this phase was in equilibrium with AmO_{2-x} up to 1020°C while for lower O/Am ratios it was in equilibrium with a hexagonal Am_2O_3. The americium oxygen system showed great similarity with the plutonium oxygen system. The results of the comparison between the Am–O system and the Pu–O, Pr–O, Tb–O, and Ce–O systems are also given. (auth)

6913 PHASE LIMITS OF U_4O_9. van Lierde, W.; Pelsmaekers, J.; Lecocq-Robert, A. (SCK/CEN, Mol, Belgium). J. Nucl. Mater.; 37: 276-85(Dec 1970).

The homogeneity range of the U_4O_9 phase was determined by x-ray analysis, metallography, chemical analysis, and electron microscopy. It extended from O/U = 2.235 to 2.240 at 1100°C and from O/U = 2.235 to 2.245 at room temperature, excluding the stoichiometric composition O/U = 2.250. The U_4O_{9-y} to UO_{2+x} transition at 1125°C was interpreted as an order-disorder transformation. (auth)

6914 PHASE REACTION IN THE UC–W SYSTEM. Ugajin, M.; Takahashi, I. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 37: 303-13(Dec 1970).

The phase reaction in the UC–W system was investigated by metallography, x-ray diffraction, microhardness measurement and electron-microprobe analysis. The results showed that in the system a peritectic four-phase reaction took place: UC + W $\rightleftharpoons$ η-UWC_2 + liquid (at 2150 ± 20°C), where η-UWC_2 denoted a low carbon form of UWC_2. The compositions of the peritectic liquid and of the peritectic point were determined to be near 48 U/34 C/18 W (at.%), respectively. The phase diagrams are presented for the U–C–W ternary and UC–W quasibinary systems. (auth)

Radiation Effects

Refer also to abstracts 6879 and 8050.

6915 (DP-Report-493) REPORT ON WORK AT A.E.R.E. FOR THE DRAGON PROJECT, NOVEMBER 1965–OCTOBER 1966. Project DRAGON. (Atomic Energy Research Establishment, Harwell (England)). Dec 1966. 12p. (AERE-PR/D-10). Dep. NTIS.

Results of research are summarized on radiation effects in coated particle fuels, fission gas release from coated particle fuels, fission product diffusion in fuels, fission product diffusion in graphite, vaporization of metal carbides, vaporization of rare earths, and properties of graphite. (J.R.D.)

6916 OBSERVATIONS DEMONSTRATING THE RE-SOLUTION OF GAS FROM BUBBLES AND SINTERING PORES DURING THE IRRADIATION OF UO_2 AT A HIGH TEMPERATURE. Turnbull, J. A.; Cornell, R. M. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 37: 355-7(Dec 1970).

An efficient re-solution process was found to exist in UO_2 samples which were irradiated to a total dose of 5×10^{22} thermal neutrons/m^2 at 1200°C. After irradiation the population of sintering pores and intragranular bubbles was drastically reduced. (G.M.C.)

6917 TEMPERATURE-DEPENDENT SWELLING IN IRRADIATED U_3Si FUEL ELEMENTS. Hastings, I. J.; Stoute, R. L. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). J. Nucl. Mater.; 37: 295-302(Dec 1970).

The volume changes in irradiated U_3Si were shown to be strongly temperature-dependent. Density values were determined as a function of radius for a series of fuel elements which operated at calculated center temperatures between 475 and 675°C. The fuel surface temperatures ranged from 315 to 440°C, and the burnups from 1500 to 8400 MWd/ton U. The volume change, $\Delta V/V$, increased from about 5% at 315°C to a maximum of about 30% at 500°C, then decreased to <1% at 675°C. No strong dependence of $\Delta V/V$ on burnup was noted in the range examined. An axial void of adequate dimensions can accommodate volume changes if the central temperature of the fuel is in the range where maximum swelling occurs. If the largest volume increase occurs close to the fuel surface, the axial void is less effective, and a diametral increase to accommodate the swelling may result. (auth)

Plastics and Other Materials

Refer also to abstracts 6350 and 7448.

6918 (CEA-CONF-1526) PROBLEMS AND VIEWS OF VESSELS OF PRESTRESSED CONCRETE. FRENCH EXPERI-

ENCE IN 1970. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 18p. (In French). (CONF-700213-1). Dep. CFSTI (U. S. Sales Only).

From Panel on Prestressed Concrete Vessels, Vienna, Austria.

The organization of French research on the properties and use of vessels of prestressed concrete is outlined. The difference in the technological problems connected with reinforced concrete and prestressed concrete in the construction of reactor vessels is discussed. The safety of prestressed concrete vessels is discussed. The present and proposed regulations to ensure the safety of prestressed concrete vessels are summarized. (J.S.R.)

6919 GAMMA RADIATION SHIELDING EFFECT OF VARIOUS HEAVY CONCRETES USING DOMESTIC MINERAL AGGREGATES. Lim, Yong Kyu (Atomic Energy Research Inst., Seoul). J. Korean Nucl. Soc.; 2: 149-61(Sep 1970).

The gamma radiation shielding performance of heavy concretes manufactured with aggregates of domestically produced mineral ores and which may be used for biological shielding were investigated. Physical test and chemical analyses for ten different kinds of mineral ores, collected for use as aggregates, were carried out to select the aggregate with the optimum shielding property. Through an investigation of the shielding effects of various concretes with different combinations of water-cement and fine-coarse aggregate ratios, it was possible to derive some criteria for obtaining the concretes with high density and good uniformity. Data on the shielding effectiveness of the different concretes were obtained by performing collimated beam experiments using ^{60}Co gamma radiation. By analyzing the shielding efficiency, shielding-concrete specific gravity, and biological shield cost, the optimum conditions of shielding and the most economic shielding design, were determined. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 7539 and 7611.

Cosmic Ray Exposure Ages

6920 PRIMORDIAL NOBLE GASES IN SEPARATED METEORITIC MINERALS. I. Jeffery, Peter M.; Anders, Edward (Univ. of Chicago). Geochim. Cosmochim. Acta; 34: 1175-98(Nov 1970).

Magnetite and a layer-lattice silicate from the Orgueil carbonaceous chondrite show strikingly different noble gas patterns. Magnetite contains He, Ne, and Ar in essentially solar proportions, with some excess Kr and Xe. Isotopic ratios are typically solar: $^{20}Ne/^{22}Ne = 12.5$, $^{3}He/^{4}He = (3.8 \pm 0.4) \times 10^{-4}$; but $^{129}Xe/^{132}Xe$ is quite high, 2.0 to 6.6. $^{4}He/^{20}Ne$ is 730, which is probably close to the true solar ratio. Silicate contains planetary gas, with $^{20}Ne/^{22}Ne = 8.2$, $^{3}He/^{4}He = (1.4 \pm 0.4) \times 10^{-4}$, and $^{129}Xe/^{132}Xe = 1.018 \pm 0.003$. The ^{21}Ne radiation age of the magnetite, 10.7 m.y., is higher than that of the bulk meteorite, 4.5 m.y., which implies substantial loss of cosmogenic ^{21}Ne from silicate. Presumably the radiation ages of other Cl chondrites are too low by similar factors. The primordial component in magnetite is loosely bound, and may represent trapped solar wind. The gas in silicate is more tightly held and was probably absorbed from the solar nebula at $350 \pm 50°K$. Data on low-temperature solubilities of He, Ne, and Ar suggest that the observed amounts and elemental fractionations of planetary gas can probably be explained by equilibrium solubility. The isotopic features of planetary gas require an additional process, such as production of ^{22}Na by charged-particle irradiation. (auth) (UK)

6921 AGE OF THE EARTH AND METEORITES. Mussett, A. E. Comments Earth Sci., Geophys.; 1: 65-73(Oct-Nov 1970).

The situation in regards to the age of the Earth is reviewed, and it is concluded that the age cannot be measured directly since no sample of the original Earth has survived intact. It could be dated if its formation left a record as inhomogeneities of the radioisotope distribution, which evolving as closed systems, would allow one to extrapolate back to the time of divergence, but the evidence is against such inhomogeneities. In the case of the meteorites, a complex development culminated about 4.5 billion years ago in the present diversity of meteorites, since when change has largely ceased, allowing one to date them by the Pb isotopes, Rb–Sr, and K–Ar methods. (W.D.M.)

6922 DIFFERENTIATION OF THE RARE EARTHS IN METEORITIC MATTER. Lavrukhina, A. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geochem. Int. (Engl. Transl.); 7: No. 1, 12-18(Oct 1970).

Translated from Geokhimiya; No. 1, 15-21(Jan-Feb 1970).

Data on the rare earths in component minerals of meteorites lead to a new concept of the distribution of these elements in meteoritic matter and of the nature of some meteorites. The hypersthene chondrites, for example, must be regarded as assemblages of minerals which have been formed as a result of differentiation, similar to that observed in terrestrial ultramafic rocks. Basaltic achondrites are mixtures of two mineral phases characterized by differentiation of the rare earths as observed in peridotites and basalts. Mutual compensation of opposing effects in bulk samples of meteorites has led previous investigators to assume that no differentiation of the rare earths has occurred in basaltic achondrites, enriched in these elements. Vinogradov's idea that the material of all types of meteorites, except chondrites, has passed through a planetary stage, can be extended to include the parent material of hypersthene chondrites, now represented by the chondrules of these meteorites. (auth)

6923 PRECISE $^{87}Rb/^{87}Sr$ AGE AND INITIAL $^{87}Sr/^{86}Sr$ FOR THE COLOMERA IRON METEORITE. Sanz, H. G.; Burnett, D. S.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Geochim. Cosmochim. Acta; 34: 1227-39(Nov 1970).

Rb–Sr analyses of silicates from the Colomera iron meteorite show a wide range in Rb/Sr and give $^{87}Sr/^{86}Sr$ values ranging from 0.699 to 8.45. These analyses define a precise linear array on the Rb–Sr evolution diagram yielding an age of $4.61 \pm 0.04 \times 10^{9}$ yr. A high-precision analysis of a whitlockite separate having very low Rb/Sr yields an initial $(^{87}Sr/^{86}Sr)_I = 0.69940 \pm 0.00004$. An upper limit of 48 ± 7 million years can be set for the time interval between dispersion of the silicate in the metal phase and final Sr isotopic equilibration, if it is assumed that Colomera silicate formed from a parent material which had the same initial $^{87}Sr/^{86}Sr$ as Ca-rich achondrites. The data are consistent with a simple evolutionary history in which Colomera differentiated from a parent material of chondritic Rb/Sr ratio at a time 39 million years after the parent material had the initial $^{87}Sr/^{86}Sr$ of Ca-rich achondrites and 35 million years before the final Sr equilibration in the Guareña chondrite. (auth) (UK)

6924 LITHIUM IN CHONDRITIC METEORITES. Nichiporuk, Walter; Moore, Carleton B. (Arizona State Univ., Tempe). Earth Planet. Sci. Lett.; 9: 280-6(1970).

Lithium determinations were made in 35 ordinary chondrites, 8 carbonaceous chondrites, and 5 enstatite chondrites, using atomic absorption spectroscopy. Significant differences in the concentrations of lithium were found in enstatite chondrites as compared to chondrites and carbonaceous chondrites. Chondrule fractions and metal-free matrices were separated from 4 out of 35 chondrites studied and lithium analyses made. These data showed a trend of lower lithium concentrations in chondrules relative to the matrices. Atomic lithium abundances of 40 to 50 for chondrites and carbonaceous chondrites, 46.0 for enstatite chondrites of Type I, and 12.5 for enstatite chondrites of Type II based on $Si = 10^{6}$ were calculated. (auth)

6925 STUDY OF THE AGE OF THE ELEMENTS. Reynolds, Michael Anthony. Fayetteville, Ark.; Univ. of Arkansas (1970). 62p. University Microfilms Order No. 70-17,194.

Thesis.

The contents and isotopic composition of xenon from three chondrites—Holbrook and Bruderheim, both hypersthene, and Beardsley, a bronzite, which belong to the groups L_6 and H_5, and xenon composition of the carbonaceous chondrites Murray are reported. The amounts of excess fissiogenic xenon (^{136f}Xe) and excess radiogenic xenon (^{129r}Xe) in the chondrites Beardsley and Holbrook were measured to be $^{136f}Xe = 0.7 \pm 0.3$ and 0.7 ± 0.3; $^{129r}Xe = 2.0 \pm 0.8$ and 13.2 ± 2.9 in the unit of 10^{-12} cc STP/g. The isotopic compositions of xenon released in a step-wise heating experiment from the chondrite Bruderheim were measured. The amounts of excess fissiogenic xenon (136^{f}) and excess radiogenic (^{129r}Xe) in this meteorite were calculated to be 0.7 and 13.0×10^{-12} cc STP/g, respectively, from the temperature release data. If ^{136}Xe and ^{129r}Xe are the decay products of extinct radionuclides ^{244}Pu and ^{129}I, produced in the galactic nucleosynthesis process, the Pu/Xe and I/Xe decay intervals for these chondrites can be shown to be concordant at approximately 200 m.y. The isotopic composition of xenon released from the carbonaceous chondrite Murray at different temperatures, showed no clear-cut sign of a sudden release of fission component throughout the temperature range between 200 and 1600°C. This indicates that the concentration of excess fissiogenic xenon is less than 10^{-11} cc STP/g. (Diss. Abstr. Int., B)

Stars

Refer also to abstracts 7012, 7734, and 7789.

6926 (NP-18544) NUCLEUS FORMATION IN STELLAR MATTER. Nemeth, J.; Kisdi, D. (Roland Eotvos Univ., Budapest (Hungary), Inst. for Theoretical Physics). Mar 1970. 10p. (ITP-272). Dep. NTIS (U. S. Sales Only).

Nucleus formation in stellar matter was examined as the function of density. The energetically most favorable relations were determined. The relative proton number, the most favorable nuclei, and the energies were determined as the function of density. There are two critical density points, the first where an outside neutron gas appears in addition to nuclei and the other where the clustering of nucleons disappears. (auth)

6927 STATIC AND DYNAMICAL MODELS OF LONG-PERIOD VARIABLE STARS. Keeley, Douglas Allan. Pasadena, Calif.; California Inst. of Tech. (1970). 153p. University Microfilms Order No. 70-12,438.

Thesis.

The parameters of the models were $M = 1$ and $1.3\ M_{\odot}$, $M_{\text{bol}} = -3.8$ to -5, and $T_e = 2200$ to $3200°K$. The equation of state included a detailed calculation of ionization equilibrium and the dissociation of H_2, OH, CO, and H_2O. The opacity of CO, OH, and H_2O was included. The dynamical calculations show that large-amplitude pulsation can occur in convective models. The opacity mechanism causes strong driving of the pulsation in the

region outside the hydrogen ionization zone, and the Γ-mechanism results in very low dissipation in the hydrogen zone. The phase relation between the bolometric luminosity and the radius variations is similar to that of Cepheids. The static models have large ionization and dissociation zones, which cause the pulsation parameter $Q = P_{days}(\rho/\rho_{\odot})^{1/2}$ to become greater than 0.15 in some models. The fundamental periods ranged from 180 days to greater than 2000 days; the overtone periods are about 1/3 as long. The positions of many observed stars in the theoretical HR diagram suggest that their periods should be associated with the overtone periods of the models. (Diss. Abstr. Int., B)

6928 AXISYMMETRIC HYDROMAGNETIC EQUILIBRIA. Nakagawa, Y. (High Altitude Observatory, Boulder, Colo.). Astrophys. Space Sci.; 8: 327-37(Sep 1970).

The physical characteristics of possible axisymmetric equilibria are examined on the basis of the integrals of hydromagnetic equations. It is shown for nearly spherical configurations that a surface differential rotation is possible only in the absence of a meridional circulation with either purely toroidal or purely poloidal magnetic field. In the presence of a meridional circulation, it is shown that no surface rotation or constant rotation is possible if the magnetic field is purely toroidal, and that no rotation is possible if the magnetic field is purely poloidal. A brief discussion is given on the possible solutions including the case of stellar winds with force-free magnetic fields. (auth)

6929 OSCILLATIONS OF A SELF-GRAVITATING FLUID SPHEROID WITH A PREVALENT MAGNETIC FIELD. Sood, N. K.; Trehan, S. K. (Panjab Univ., Chandigarh, India). Astrophys. Space Sci.; 8: 422-31(Sep 1970).

The Kelvin modes of oscillation of a self-gravitating, homogeneous fluid spheroid in hydrostatic equilibrium with a poloidal magnetic field inside and a dipole type field outside, are studied, using a variational principle. On the assumption that the eccentricity e of the spheroid is small, the frequencies of oscillation are calculated to the first order in e^2. (auth)

6930 NEUTRINO SYNCHROTRON RADIATION. I. APPLICATION TO WHITE DWARFS. Chaudhuri, Probhas Ray (Indian Statistical Inst., Calcutta). Astrophys. Space Sci.; 8: 432-47 (Sep 1970).

The neutrino synchrotron radiation for a completely relativistic electron gas in the presence of large magnetic field is computed according to the photon–neutrino coupling theory of weak interactions. The radiation is also estimated for the nonrelativistic case. The neutrino luminosity of several model white dwarfs is computed according to the photon–neutrino coupling theory and compared with that of the current–current coupling theory. It is shown that, according to the photon–neutrino coupling theory, the neutrino luminosity is greater than the photon luminosity and, therefore, most likely to have astrophysical significance in the evolution of stars with large electron energies and potentially large magnetic field, such as white dwarfs. (auth)

6931 NEUTRINO SYNCHROTRON RADIATION. II. APPLICATION TO NEUTRON STARS. Chaudhuri, Probhas Ray (Indian Statistical Inst., Calcutta). Astrophys. Space Sci.; 8: 448-56 (Sep 1970).

The neutrino luminosity of several models of neutron stars was computed according to the photon–neutrino coupling theory and compared with that of the current–current coupling theory. It is shown that the NSR process alone should have cooled the core of the neutron star created in a supernova explosion in 1054 A.D. to a temperature around 2×10^9 K according to the photon–neutrino coupling theory. The emission power of the star is greater than the emission power of the x-ray source discovered in the Crab Nebula; so the source may be interpreted as the thermal radiation of the star according to the photon–neutrino coupling theory. (auth)

6932 POSITRONS AND LOW-ENERGY COSMIC RAYS FROM SUPERNOVAE. Colgate, Stirling A. (New Mexico Inst. of Mining and Tech., Socorro). Astrophys. Space Sci.; 8: 457-62(Sep 1970).

Burger et al. (1970) calculated the positron flux from the decay of $^{56}Co \rightarrow {}^{56}Fe$ from cosmic rays injected from supernovae. The plasma properties of the ejected matter are determined in order to include the ionization loss of the positrons as the matter expands. It is found that using the matter velocity distribution of previous supernova model calculations that roughly 10% of the positrons escape. The average lifetime in the Galaxy due to ionization loss is found to be relatively small, 1.5×10^5 yr, and with the above injection results in ×3, the observed flux. The same matter velocity distribution is subjected to ionization loss in the Galaxy and a steady-state low-energy, $10 \leq E \leq 200$ MeV, differential flux spectrum is found, $J(E) \sim E^{-1.2}$. This removes the difficulty of the high galactic energy density resulting from a steeper spectrum. (auth)

6933 EVOLUTION OF OB STARS FROM THE MAIN SEQUENCE TO THE HELIUM EXHAUSTION PHASE. Chiosi, C.; Summa, C. (Univ., Padua). Astrophys. Space Sci.; 8: 478-96 (Sep 1970).

The evolution of a 20 $M_{\odot}$ star of extreme Population I (X = 0.602, Z = 0.044) from the main sequence through He-exhaustion was calculated with particular attention to the treatment of the semiconvective zones. Two different relations as convective instability criteria were adopted ($\nabla_R \geq \nabla_a + (\beta/(4-3\beta))$ (d lnμ/d lnP) or $\nabla_R \geq \nabla_a$). The He-burning phase is substantially different in the two cases. In the first evolutionary picture the star begins the He-burning phase as a red supergiant, while in the second one as a blue supergiant. The two evolutions are compared with the observational blue to red supergiants ratio n_B/n_R in connection with the problem of the existence of the neutrino processes and taking into account the possible presence of a high percentage of binary systems among supergiants. The conclusion is drawn that the massive star evolution seems to be still completely uncertain and also not able to give a decisive test for or against neutrino emission. (auth)

6934 ARE THERE STARS EXCEPTIONALLY BRIGHT AT 1500 Å? Weber, Stephen V. (Naval Research Lab., Washington, D. C.); Henry, Richard C.; Carruthers, George R. Astrophys. J.; 162: L121-4(Nov 1970).

Interstellar reddening at 1500 Å was measured for more than a dozen stars. A few stars, including θ Ori, have apparently anomalous ultraviolet reddening. However, unreddened B stars also anomalously bright at 1500 Å by about 1.3 mag are shown probably to exist, and it is suggested that θ Ori may be one of these bright objects, reddened according to the same law that describes the reddening of other stars. (auth)

6935 DETECTION OF CELESTIAL SOURCES AT FAR-INFRARED WAVELENGTHS. Friedlander, M. W.; Joseph, R. D. (Washington Univ., St. Louis). Astrophys. J.; 162: L87-91 (Nov 1970).

Four sources of apparent flux $\sim 10^{-13}$ W cm^{-2} and angular size <0.5° were detected in the wavelength region between 45 and 250 μ during a sky survey with a balloon-borne telescope at an altitude of 28 km. The source positions are not uniquely identifiable with sources prominent in other spectral regions. (auth)

6936 POSSIBLE IDENTIFICATION OF PROMETHIUM IN HR 465. Aller, Margo F.; Cowley, Charles R. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 162: L145-8(Nov 1970).

Evidence is presented for the possible presence of Pm in the Ap star HR 465. (auth)

6937 POSSIBILITY OF NEUTRON-STAR FORMATION IN A CARBON-DETONATION SUPERNOVA. Wheeler, J. Craig; Barkat, Zalman; Buchler, Jean-Robert (California Inst. of Tech., Pasadena). Astrophys. J.; 162: L129-32(Nov 1970).

A study of thermonuclear detonation in evolved stellar cores shows that if a detonation occurs at a central density less than a critical value ($\rho_{crit} \sim 6 \times 10^9$ g cm^{-3}) which is mainly dependent on the rates of β-processes (and associated Urca losses) no remnant is left. The nearly identical cores of red-giant stars in the mass range $3.5 \lesssim M/M_{\odot} \lesssim 8$ have been independently suggested to lead to carbon-detonation supernovae and to the formation of pulsars. It is verified that these suggestions are incompatible because the models undergo carbon ignition at a central density less than ρ_{crit}. If a remnant is to be left, it is necessary either that carbon detonation does not occur or that β-processes are more efficient. (auth)

6938 SPECTRAL ENERGY DISTRIBUTION OF EIGHT STARS. Komarov, N. S.; Pozigun, V. A. (Odessa Astronomical Observatory). Sov. Astron. AJ (Engl. Transl.); 14: 440-4 (Nov-Dec 1970).

Translated from Astron. Zh.; 47: 551-6(May-Jun 1970).

The spectral energy distribution of eight stars of various spectral types is reported. The results are compared with Willstrop's measurements. (auth)

6939 MEASUREMENTS OF CAPELLA WITH THE PULKOVO STELLAR INTERFEROMETER. Kulagin, E. S. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 445-7(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 557-9(May-Jun 1970).

During the winter of 1968–1969, 12 measurements of the binary

star Capella were made with the 6-m baseline stellar interferometer at Pulkovo. The companion described an arc of about 270° during the course of these observations. It is shown that the orbit obtained by Merrill for Capella in 1921 from the first interferometric measurements still provides a good fit to the observations. (auth)

6940 METHOD FOR DETERMINING THE SELECTIVE ABSORPTION AND DISTANCE TO AN OPEN CLUSTER FROM ITS COLOR–MAGNITUDE DIAGRAM, WITH ALLOWANCE FOR THE EVOLUTIONARY DEPARTURES OF ITS STARS FROM THE ZERO-AGE MAIN SEQUENCE. Uranova, T. A. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 448-52 (Nov-Dec 1970).

Translated from Astron. Zh.; 47: 560-5(May-Jun 1970).

A method is proposed for determining the color excess E_{B-V} and the distance modulus ρ_0 from the color–magnitude diagram alone in the case of open clusters for which three-color photometry is not available. By allowing for the evolutionary departures of the stars from the zero-age main sequence, systematic errors are avoided that would ordinarily render the E and ρ_0 determinations highly unreliable if the stars in the color–magnitude diagram were simply fitted to the standard main sequence. The method is applied to 36 clusters not included in the derivation of the systematic corrections. The results are comparable in accuracy to the methods of Johnson, Becker, and Starikova, which require three-color photometry. Determinations of ρ_0 and E by the new method are reported for two open clusters, IC 1369 and NGC 1582, for which three-color photometry is not available. (auth)

6941 SOME DETERMINATIONS AT PULKOVO OF ABSOLUTE STELLAR PROPER MOTIONS RELATIVE TO GALAXIES. Fatchikhin, N. V. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 495-504(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 619-32(May-Jun 1970).

In accordance with Zverev's plan for a catalog of faint stars, extensive material is used to refine previous results, and some topics not examined earlier are discussed. The compilation of a catalog of 14,600 stars (including 1372 AGK3 stars) referred to 281 galaxies in 85 fields of the sky was completed. The brightness of the stars was determined with a diffraction grating; the probable error in the international photographic magnitude is ±0.18. A brightness equation was detected in 40 of the fields, primarily in the proper-motion component μ_y, and the corresponding corrections were made in the catalog. An analysis reveals certain peculiarities in this error, in particular a seasonal dependence. The difference between the proper motions of 779 stars in the AGK3 and in our catalog (corrected for brightness equation) yields a correction $\Delta p_l = +0.0104'' \pm 0.0008''$, $-\Delta E = -0.0053'' \pm 0.0008''$ to Newcomb's precession constant, which differs little from the previous value, and also the systematic differences shown graphically. At the equator, the differences $(\Delta\mu_\alpha)\delta$ have diminished to 0.0070″, which is 0.0070″ smaller than previous results. A comparison is made between the reduction of relative to absolute proper motions of 15.0 m stars with respect to galaxies, to AGK3 stars, and statistically. Good agreement is found between the configuration of the curves for the galaxy and the AGK3 reductions, while the reductions with respect to the statistical data are in poorer agreement with the other curves. A statistical evaluation of the reduction is made from the parallactic displacement of the stars due to solar motion and galactic rotation. The coordinates of the solar apex, the secular parallax, and Oort's constants are determined relative to stars of photographic magnitude 15.0. If the galaxies are distributed asymmetrically about the optical plate center, the reduction of relative to absolute stellar proper motions, evaluated as the mean "proper motion" of the galaxies with opposite sign, could contain a systematic error. (auth)

6942 INFLUENCE OF STELLAR WIND ON ACCRETION. Shvartsman, V. F. (Inst. of Applied Mathematics, Moscow. Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 527-8(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 660-2(May-Jun 1970).

There is a "critical" intensity for a stellar wind below which ejection of particles from the star should be replaced by accretion of the surrounding gas. If the infall of material is itself capable of providing sufficiently effective mechanisms for generating fast particles, the intensity of the accretion process will be limited, and both accretion and ejection will operate concurrently. (auth)

6943 PHOTOELECTRIC STUDY OF THE MAGNETIC STAR β CORONAE BOREALIS. Brodskaya, E. S. (Crimean Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 529-30(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 662-4(May-Jun 1970).

Photoelectric observations of the periodic magnetic variable β CrB were made during the 1966 and 1968 seasons in approximately the UBV system. The brightness was found to vary in the same period as the magnetic field. Maximum brightness coincided with maximum positive field in all wavelength regions. The minima of the B and U curves were shifted in phase by 0.09 and 0.16 cycle, respectively. (auth)

6944 Z MOTIONS OF GROUPS OF EARLY-TYPE STARS AND ORION VARIABLES. Artyukhina, N. M. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 533-4(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 667-8(May-Jun 1970).

Two groups of Orion variables in Taurus and the group of OB stars in the Cep II association are shown to be approaching the galactic plane. The values of V_Z for star groups in Orion and in the ζ Per association are nearly zero. (auth)

6945 CHARACTER OF THE PECULIAR-VELOCITY DISTRIBUTION IN DIFFERENTIALLY ROTATING STELLAR SYSTEMS. Maksumov, M. N. (Inst. of Astrophysics, Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 535-6(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 668-71(May-Jun 1970).

With the simple model of a stationary, differentially rotating stellar system as an illustration, it is shown that the peculiar-velocity distribution should be anisotropic. The treatment rests on an approximate solution of the Boltzmann equation for a distribution function incorporating the symmetry of the problem and written in a reference system moving along with the local centroid. This feature distinguishes the analysis from that of other authors. (auth)

6946 SYMMETRY ENERGY OF NUCLEI AND ITS ASTROPHYSICAL APPLICATIONS. Nemeth, J. (Roland-Eoetvoes-Univ., Budapest). pp 941-50 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970). See STI/PUB-249.

Nuclear-matter concepts and calculations are used to explain the structure and the evolution of neutron stars. (auth)

6947 PHOTOELECTRIC STUDY OF Be STARS. Boone, Joseph Calhoun. Madison, Wis.; Univ. of Wisconsin (1970). 92p. University Microfilms Order No. 70-8270.

Thesis.

Balmer jumps and equivalent widths of the first three Balmer lines were measured for twenty-seven bright Be stars and twenty-nine normal B stars. By comparing the observed Balmer jumps of normal B stars with the Balmer jumps of available stellar models, an effective temperature scale for stars from B0 to B7 was determined. The emission in the Balmer continuum and the Balmer lines was calculated by comparing the Be stars with stellar models and normal B stars. The H-alpha, H-beta ratio shows a smaller variation from star to star than other observers have found, suggesting that Be envelopes may be a rather homogeneous group of objects. Further, the average value of this ratio is close to 2.2, lower than earlier determinations. Relative to the Balmer continuum emission, the emission in the first three Balmer lines is much less than would be expected if Be star envelopes were comparable to planetary nebula models. The observations indicate that the envelope is optically thin in the Balmer continuum, and optically thick in the lower Balmer lines. There is some indication that pole-on stars have stronger Balmer continuum emission relative to H-alpha and H-beta than equator-on stars. If Be envelopes are somewhat disc shaped, this difference may be due to the increased self-absorption in the Balmer continuum for envelopes viewed equator-on. (Diss. Abstr. Int., B)

6948 OPTICAL STUDIES OF CASSIOPEIA A. I. PROPER MOTIONS IN THE OPTICAL REMNANT. van den Bergh, Sidney (California Inst. of Tech., Pasadena. Univ. of Toronto); Dodd, W. W. Astrophys. J.; 162: 485-93(Nov 1970).

Sixteen 200-inch plates taken between 1951 and 1968 were used to study the expansion of the optical remnant of Cas A. If it is assumed that no deceleration occurred, the explosion of this supernova took place in A. D. 1667 ± 8 (m.e.). The position of the center of expansion is found to be $\alpha_{1950} = 23h21m11.4s \pm 0.2s$, $\delta_{1950} = +58°32'18.9'' \pm 3.1''$. No star brighter than V = 22.5 is visible within 8 standard deviations of this position. If values of $A_v = 6.8$ and D = 2.8 kpc are assumed, it follows that any remaining stellar remnant must be fainter than $M_v = +3.5$. The optical remnant of Cas A is undergoing rapid changes. The average decay time scale for moving knots is found to be about 10 years. (auth)

6949 SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. XVII. THREE PLANETARIES WITH MARKED

STRATIFICATION EFFECTS: NGC 6309, NGC 7026, AND IC 1747. Czyzak, S. J. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware); Aller, L. H. Astrophys. J.; 162: 495-505(Nov 1970).

Pronounced stratification effects are observed in a number of planetaries including the ring-amorphous structure NGC 6309 and the binuclear objects NGC 7026 and IC 1747. All three show relatively high excitation in the inner regions, but a pronounced dependence of the intensity of λ4686 He II, λ3727 [O II], and λ4968 [S II] on position in the nebula. (auth)

6950 PROFILE OF He I λ10830 IN NGC 7027 AND THE ORION NEBULA. Robbins, R. R. (Univ. of Texas, Austin). Astrophys. J.; 162: 507-11(Nov 1970).

Image-tube slit spectra of NGC 7027 support the hypothesis that the broadening of λ10830 is primarily determined by resonance transfer in a differentially expanding medium. It is argued that the variety of profile shapes seen in Fabry–Perot observations of planetaries may be understood as a consequence of asymmetries in the distribution of emitting material. However, the Orion profiles measured by Vaughan are narrower than simple nebular models with resonance broadening would predict. The possibility of absorption in the short-wavelength side of the line by OH sources in Orion is discussed, but this mechanism appears to be insufficient. (auth)

6951 EJECTION OF PLANETARY-NEBULA SHELLS. Faulkner, D. J. (Australian National Univ., Canberra). Astrophys. J.; 162: 513-22(Nov 1970).

The force exerted on a stellar envelope by radiation pressure acting through the electron-scattering opacity is considered, and it is found that sufficient momentum may be transferred to eject a planetary shell. An order-of-magnitude treatment of the ejection of a 0.2 $M_\odot$ shell from a 1.0 $M_\odot$ nucleus in which energy production is increasing linearly with time gives a final expansion velocity in good accord with observed values. The total energy requirements for the mechanism are reasonable, and the luminosities required are in keeping with the results of stellar-interior calculations and with the observed luminosities of the central stars. The mechanism is insensitive to the exact conditions in the star at the time of ejection, so that most stars of ~1.2 $M_\odot$ can be expected to pass through the planetary nebula stage. The separation of the shell from the nucleus at the hydrogen-rich, helium-rich discontinuity is also explained. (auth)

6952 STUDY OF THE BLUE STRAGGLERS IN THE OPEN CLUSTER NGC 7789. Strom, K. M. (State Univ. of New York, Stony Brook); Strom, S. E. Astrophys. J.; 162: 523-33(Nov 1970).

Image-tube spectrograms and Strömgren 4-color and Hβ photometry were obtained for twelve possible blue-straggler members of the open cluster NGC 7789. Membership was established for eight of these twelve blue-straggler candidates. From the data obtained, it was possible to test three competing hypotheses for the origin of these stars. Estimates of masses based on a match of the photometry with model atmospheres show that blue stragglers have masses appropriate to their location in the color-magnitude diagram. Furthermore, of four blue-straggler members studied carefully for radial-velocity variations, all four exhibited definite changes in velocity. These observations suggest strongly that blue stragglers are members of binary systems in which mass exchange has taken place. (auth)

6953 WOLF–RAYET STARS. IV. LINE INTENSITIES IN THE SPECTRA OF TWO WN6 STARS. Smith, Lindsey F. (Univ. of Colorado, Boulder); Kuhi, Leonard V. Astrophys. J.; 162: 535-45(Nov 1970).

Coudé spectrograms and photoelectric scanning were used to obtain intensities of emission lines in the spectra of two WN6 stars, HD 192163, and HD 191765, and thus provide data for the theoretical analysis of the atmospheres by Castor and Van Blerkom. A comparison is made with the measurements of HD 191765 by Underhill. It is clear that the profiles of the emission lines are intrinsically variable. Reddening corrections are reevaluated. It is concluded that the continuum colors of W–R stars are approximately 0.16 mag redder in (B – V) than main-sequence O and B stars with the same (U – B). (auth)

6954 SPECTRUM VARIATIONS IN A-TYPE SUPERGIANTS. Rosendhal, Jeffrey D. (Univ. of Wisconsin, Madison); Wegner, Gary. Astrophys. J.; 162: 547-56(Nov 1970).

A detailed investigation was made of the changes in line strengths and microturbulence in the three high-luminosity A stars 6 Cas (A3 Ia+), 9 Per (A2 Ia), and ν Cep (A2 Ia). The results of the analysis suggest the existence of a correlation among absolute magnitude, mean value of the microturbulence, and amplitude of variability of both microturbulence and radial velocity. In addition, the presence of a strong correlation between the behavior of the microturbulence and the radial velocity in the case of 6 Cas and 9 Per indicates the existence of a strong coupling between large-scale and small-scale mass motions in the high-luminosity A stars and provides observational evidence for the occurrence of nonlinear aerodynamic processes in the atmospheres of these stars. (auth)

6955 VY CANIS MAJORIS. II. INTERPRETATION OF THE ENERGY DISTRIBUTION. Herbig, G. H. (Univ. of California, Santa Cruz). Astrophys. J.; 162: 557-70(Nov 1970).

Multicolor photometric observations of VY CMa between 0.36 and 22 μ were interpreted in terms of a model consisting of a dust disk surrounding and hiding a star with an energy distribution like that of α^1 Her. The emitted continuous spectrum was separated into two components: one scattered in the disk, and another due to thermal emission by solid particles. The radial $T(\tau)$ distribution in the disk was obtained by a method, due to Huang, for solving the transfer equation in spherical coordinates under the simplification of gray particles and the Eddington approximation. The surface flux was then found at each wavelength by using a procedure due to Larson of integration over angle and depth. The resulting non-Planckian spectrum represents the multicolor observations satisfactorily; the temperature range is from 350°K at the outer surface of the disk to 1515 or 1850°K at the inner surface, depending upon which of two alternative models for the radial density distribution is chosen. The absolute values of the inner and outer radii depend on the disk thickness that is assumed; for a case where the dust is confined between latitudes ±20°, these radii are about 60 to 90 and 1000 to 1500 AU, respectively. The fit requires that, within the framework of this theory, the particles have a high value of the single-scattering albedo, about 0.9. The total mass of the disk (gas plus dust) is about 0.1 $M_\odot$. The time required, only a few hundred years, for a particle to move the radial thickness of the disk, traveling at the mean expansion velocity inferred from the duplicity of the microwave lines of OH and H_2O, suggests that the disk is a short-lived phenomenon. These calculations all assume that VY CMa is a member of the young association associated with τ CMa, NGC 2362, and the H II region Sharpless 310, at a distance of 1.5 kpc. The overall picture is that of formation of dust and molecules in this circumstellar ring or "solar nebula" about VY CMa, the disk now being in the process of radial dissipation by particle or radiation pressure from the young M-type central star. (auth)

6956 ULTRAVIOLET AND VISUAL SPECTRA OF GAMMA CASSIOPEIAE. Bohlin, Ralph C. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 162: 571-87(Nov 1970).

A rocket ultraviolet spectrum of γ Cas (B0.5 IVpe) was obtained with a resolution of about 2 Å between 1060 and 2130 Å on November 15, 1968. The strength of the interstellar La absorption line corresponds to an average density of 0.15 atoms cm^{-3} of neutral hydrogen over the 220 pc to γ Cas, while the absence of any observable lines of molecular hydrogen yielded an upper limit of 2.4×10^{-3} molecules cm^{-3}. Possible interstellar absorption lines of C II, N I, and Si II have widths that indicate that the low-density gas in which the lines arise may have an exponential velocity distribution with a dispersion of $\eta = 15$ km sec^{-1}. The C IV line at 1550 Å is the only spectral feature with a P Cygni profile. OAO and visual spectra covering the wavelength range 1100 to 5000 Å are also analyzed. The measured amount of Balmer continuous emission can be used to explain the weakness of the He I and other visual photospheric lines if the temperature and optical depth of the circumstellar envelope are known. If γ Cas has an envelope consisting of discrete clouds, each of which has an optical depth of unity at 3647 Å and an electron temperature of 20000°K, then the Balmer continuous emission is accounted for quantitatively and the line profiles in the ultraviolet and visual can be explained qualitatively. (auth)

6957 IDENTIFICATION OF [Cr II] LINES IN ASTRONOMICAL OBJECTS AND TRANSITION PROBABILITIES OF FORBIDDEN LINES OF SINGLY IONIZED CHROMIUM. Nussbaumer, H.; Swings, J. P. (Univ. of Colorado, Boulder). Astrophys. J.; 162: 589-96(Nov 1970).

The magnetic-dipole and electric-quadrupole transition probabilities are computed for the configurations $3d^5$ and $3d^44s$ of Cr II. The presence of [Cr II] lines in η Car and in HD 45677 is discussed. (auth)

6958 METALLIC-LINE A STARS AND PULSATION. Breger, Michel (State Univ. of New York, Stony Brook). Astrophys. J.; 162: 597-604(Nov 1970).

The short-period variability of Am stars was investigated. In the Praesepe and Hyades clusters all of the 11 Am stars examined

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were nonvariable. Of twenty-seven stars with normal spectra in these clusters, ten were δ Scuti variables with amplitudes larger than 0.010 mag, four were possibly variable, and thirteen stars were nonvariable. Data collected for a large sample of the field and cluster stars falling within the δ Scuti instability strip show that the classical Am stars are stable against pulsation whereas more than 30% of the normal stars are variable. The connection between pulsational stability and Am characteristics outside the classical Am region is less clear. Model-atmosphere abundance analyses find the Am characteristic in the late variables outside the classical Am region, δ Sct and ρ Pup, less pronounced than previous curve-of-growth analyses. The metal underabundance of the variable δ Del is confirmed by the fine analysis. The hypotheses that (i) Am characteristics tend to inhibit pulsation or (ii) pulsation destroys the observable Am characteristics (which would be in a thin surface layer only) are discussed briefly. (auth)

6959 LATE EVOLUTION OF SOLAR-MASS STARS. Vila, S. C. (Univ. of Pennsylvania, Philadelphia). Astrophys. J.; 162: 605-11(Nov 1970).

The evolution of a 1 $M_\odot$ star, initially composed of a carbon core and a helium envelope, was studied by detailed model calculation on the two assumptions of energy losses due to photons and neutrinos and to photons alone. In the evolution, which takes no account of neutrinos there were found: (a) a phase of quiet helium shell burning, (b) a phase during which thermal oscillations occur, and (c) a phase of central carbon burning. The assumption of energy loss due to neutrinos suppresses both the thermal oscillations and the central carbon burning. The star develops an extended envelope, and the luminosity reaches values comparable to the critical value for mass ejection, but no mass loss is apparent from these models. The star evolves into a white dwarf in both cases, but the core composition and the mass in the remaining helium envelope differ in the two cases. (auth)

6960 EVOLUTION OF LOW-MASS STARS. II. EFFECTS OF PRIMORDIAL DEUTERIUM BURNING AND A NONGRAY SURFACE CONDITION DURING PRE-MAIN-SEQUENCE CONTRACTION. Grossman, A. S. (Iowa State Univ., Ames); Mutschlecner, J. P.; Pauls, T. A. Astrophys. J.; 162: 613-19(Nov 1970).

The lifetime of the deuterium main sequence was investigated for stars in the mass range 0.03 to 0.2 $M_\odot$ at the composition X = 0.68, Y = 0.29, and $X_D = 0.19 \times 10^{-3}$. The duration of the deuterium main sequence for an l/H_p ratio of 1 varies from 2.4×10^6 years at 0.2 $M_\odot$ to 2.3×10^7 years at 0.03 $M_\odot$. The theoretical $l/H_p = 1$ hydrogen main sequence was determined, and it is shown that a 0.08 $M_\odot$ star will reach a stable main-sequence phase in about 5×10^9 years. The mass limit for a star of this composition on the main sequence is between 0.07 and 0.08 $M_\odot$. The suggestion is made that van Biesbroeck's star might actually be a main-sequence member at or near the lower mass limit. Incorporated into the calculation of the surface boundary condition are nongray, flux-corrected model atmospheres which are used to approximate the thin outer radiative surface layers in the region of the photosphere. Water-vapor and CO opacity sources are included in these model atmospheres. The major effect of the new surface condition is to shift the theoretical main sequence toward lower luminosities and effective temperatures. (auth)

6961 MECHANISM FOR THE OUTBURSTS OF U GEMINORUM STARS. Osaki, Yoji (Columbia Univ., New York). Astrophys. J.; 162: 621-32(Nov 1970).

Adopting Kraft's close-binary model for dwarf novae, a model is proposed for the steady-state structure of the envelope of the cool component, which is assumed to be steadily losing mass to its companion. It is assumed that the shear flow over the surface due to this mass loss is turbulent, and therefore shear-flow turbulence is included as a mechanism of energy transport in the convection zone. The stability of such models to finite perturbations in the mixing length for shear-flow turbulence (equivalent to perturbations in the mean horizontal flow) is explored. Some models relax to the original steady-state solutions on the Kelvin time scale of the surface convection zone; other models undergo sustained thermal-relaxation oscillations. For unstable models maximum light occurs when the cool component overflows the Roche limit by a large amount, for then the energy transport is greatly enhanced by shear-flow turbulence; minimum light, on the other hand, occurs when the star's radius falls below the Roche limit, for then there is no transport by shear-flow turbulence. The light curves have cycles of about 15 days and amplitudes of 1.5 mag, in qualitative agreement with some of the small-amplitude U Gem stars. (auth)

6962 WEIGHTS IN KOPAL'S ITERATIVE METHOD FOR TOTAL ECLIPSES. Linnell, Albert P.; Proctor, Deanne D. (Michigan State Univ., East Lansing). Astrophys. J.; 162: 683-6(Nov 1970).

Proper weighting of photoelectric observations leads to a fundamental equation in Kopal's iterative method which differs slightly from the form given by Kopal. (auth)

6963 UBVRI PHOTOMETRY OF NORTH GALACTIC POLE K GIANTS. Helfer, H. L.; Sturch, C. (Univ. of Rochester, N. Y.). Astron. J.; 75: 971-8(Nov 1970).

UBVRI colors of 132 K giants in the North Galactic Pole region are reported. Values of [Fe/H] derived from the photometry indicate little variation of metal abundance with height above the galactic plane up to 1 kpc. The mean color excess of these stars is estimated to be 0.005 ± 0.005m. It appears as if the gravitational potential difference between the galactic plane and z = 500 pc may be only ~½ of that normally adopted (e.g., Hill 1960). (auth)

6964 STANDARD STARS FOR UVBY PHOTOMETRY. Crawford, D. L.; Barnes, J. V. (Kitt Peak National Observatory, Tucson, Ariz. Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. J.; 75: 978-98(Nov 1970).

Extensive photoelectric photometric observations at Kitt Peak National Observatory and Cerro Tololo Inter-American Observatory, on the Strömgren four-color system, were compiled for 122 stars. These data were combined with previously published data to establish 304 stars as standard stars for the uvby system. These data define the standard system. Data for an additional 50 stars of special interest are given. (auth)

6965 G-BAND VARIATION OF BETA DORADUS. Estes, James K.; Wood, H. John (Leander McCormick Observatory, Charlottesville, Va.). Astron. J.; 75: 999-1000(Nov 1970).

Observations of the G band at λ4308 Å in the spectrum of the 9.8-day Cepheid β Dor show a temperature range of 1550°K over the period. Earlier studies of the wing profiles of Hα had shown a temperature range one-third as large. It is concluded that chromospheric emission effects in the Hα profiles leads to the discrepancy and that β Dor is normal for its period. (auth)

6966 SPECTRAL CLASSIFICATION IN THE ASSOCIATION III CEPHEI AND THE RATIO OF TOTAL-TO-SELECTIVE ABSORPTION. Garrison, R. F. (Univ. of Toronto). Astron. J.; 75: 1001-6(Nov 1970).

III Cephei is one of the youngest associations within 1 kpc and is considered to be one of the best cases for a high ratio of total-to-selective absorption. Accurate spectral classifications from new McDonald spectrograms are presented for 72 of the stars listed by Blaauw, Hiltner, and Johnson (Astrophys. J., 130; 69 (1959)). There is considerable scatter in the H–R diagrams, some of which is due to the large number of single- and double-line spectroscopic binaries. However, the results indicate that the ratio R = 3.0 is suitable for the O–B5 stars, and that the suggestion of a higher ratio was influenced by the inclusion of a number of foreground stars later than B6. Foreground reddening is approximately 0.5 mag. (auth)

6967 MEASUREMENT OF K-LINE ABSOLUTE MAGNITUDES. Lutz, Thomas E. (Univ. of Illinois, Urbana. Washington State Univ., Pullman). Astron. J.; 75: 1007-14(Nov 1970).

The methods used to measure the width of the Ca II emission, correct for broadening due to the spectrograph, and calibrate the corrected widths against absolute magnitude are examined critically. An objective method of measurement is developed. The new measurements are corrected for spectrograph broadening using the assumption that the profiles are Gaussian. The corrected widths agree with those obtained by Wilson. Finally, a least-squares technique that allows for error in both variables is used to estimate the relationship between M_v and log W_0. (auth)

6968 STOCHASTIC VARIABLE STARS. Deeming, T. J. (Univ. of Texas, Austin). Astron. J.; 75: 1027-32(Nov 1970).

The light variations of some irregular variable stars can perhaps be interpreted as stochastic (random) processes with finite and fairly simple autocorrelation functions. Such processes can be generated by filtering random noise and as the solutions to differential equations containing random terms. These solutions correspond to the effect of a random driving force on a physical system such as an exponential decayer or a simple oscillator, and physical parameters of the system can be derived from the autocorrelation function of the light curve. Computer-simulated light curves show many of the features of observed light curves. Fairly straightforward refinements to suit each individual system should produce quite good agreement with observation. (auth)

6969 SPECTRAL-LINE FORMATION BY NONCOHERENT SCATTERING. McCormick, N. J. (Univ. of Washington, Seattle); Siewert, C. E. Astrophys. J.; 162: 633-47(Nov 1970).

The (singular) eigenfunction-expansion technique is used to construct solutions to a general class of nongray-model problems in the theory of radiative transfer for plane-parallel media. The model considered allows for completely incoherent scattering and continuum absorption, both of which are assumed to be independent of depth. The radiation intensity is obtained for an arbitrary space-dependent Planck function in a semi-infinite atmosphere. In addition, simplified results are obtained for the special cases where the Planck function varies either linearly or exponentially with the optical depth in the continuum. Solutions are obtained in terms of H-functions, which can be calculated once the frequency-dependent scattering and absorption coefficients are specified. (auth)

6970 OLD OPEN CLUSTER NGC 2420. Cannon, R. D.; Lloyd, C. Mon. Notic. Roy. Astron. Soc.; 150: 279-97(1970).

Relative proper motions, photographic magnitudes, and colors were determined for stars brighter than B ~ 16 that lie within 12′ of the open cluster NGC 2420. These were used to obtain a color–magnitude diagram consisting almost entirely of cluster members. This diagram was compared with those of other clusters, and it appeared that NGC 2420 is certainly more than 10^9 years old. However, there are some unusual features, which may indicate a chemical composition intermediate between those typical of open and globular clusters. The absolute proper motion of the cluster is small. (auth) (UK)

6971 NEUTRAL STABILITY AGAINST CONVECTION IN GENERAL RELATIVITY. Islam, Jamal N. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 150: 237-52(1970).

It is shown that in general relativity, under certain restrictions, a necessary condition for a star in hydrostatic equilibrium to possess neutral modes of convection is that the temperature gradient should be adiabatic. The problem can be analyzed in terms of spherical harmonics of index l, which behave independently. It is shown that, if the temperature gradient is not adiabatic, for l = 1 and $l \geq 4$ no neutral modes of convection exist, and for l = 2, 3 no neutral modes exist if $p \leq \beta\rho c^2$, where $\beta = \cdot 11$ for l = 2 and $\beta = 1$ for l = 3. For $l \neq 1$ the assumption is made that the density is nonincreasing outwards. It is also shown that the Lagrangian change in the density and pressure vanish for all l, independent of restrictions on the pressure and density, if neutral modes are to exist. (auth) (UK)

6972 ATMOSPHERES OF THE F SUPERGIANTS. Osmer, Patrick Stewart. Pasadena, Calif.; California Inst. of Tech. (1970). 130p. University Microfilms Order No. 70-12,493.

Thesis.

Coude spectra of 26 supergiants of spectral types F2–G5 were obtained, and spectrophotometric observations of four which occurred in clusters were made. A photoelectric system for measuring the O I 7774 line was established, and the line strength was determined in 59 AO–G3 stars of luminosity classes Ia–V. By calibrating the line strength in 10 F supergiants of known luminosity it was found that it indicates the absolute magnitude of F stars brighter than $M_V = -4$ with an accuracy of ±0.5m. The curves of growth obtained from the spectra show that the microturbulence determined from the Fe II lines increases with luminosity and is correlated with the oxygen line strength. However, the Fe I microturbulence exhibits a different behavior near spectral type F5, where it is insensitive to luminosity. (TSS) (Diss. Abstr. Int., B)

6973 DIFFUSION PROCESSES IN A-PEC STARS AND NUCLEOSYNTHESIS IN Si BURNING. Michaud, Georges J. Pasadena, Calif.; California Inst. of Tech. (1969). 212p. University Microfilms Order No. 70-12,491.

Thesis.

Two problems related to elemental abundances were studied: the abundance anomalies in A–pec stars and the nucleosynthesis of elements between ^{28}Si and ^{59}Co. Diffusion processes were found to lead to most of the peculiar abundances observed in A-pec stars. If it is assumed that the atmosphere is stable enough for diffusion processes to be important, gravitational settling leads to the underabundances of He, Ne, and O in the stars where they are observed (that is with the θ_{eff}, log g they are observed to have). Radiation pressure leads to the overabundances of Mn, Sr, Y, Zr, and the rare earths in the stars where they are observed. Si would be expected to be overabundant only if it has wide auto-ionization features. The overabundance of P is not explained. The magnetic fields observed in A-pec stars could bring to the atmosphere the stability needed for diffusion processes to be important. They would also guide diffusion into patches leading to the periodic variation of the observed overabundances. The conditions necessary to generate through nuclear reactions the abundances observed between ^{28}Si and ^{59}Co were also studied. It was found that most of the observed abundances could have been generated in a single process, Si burning. A mixture of ^{28}Si, ^{30}Si, and ^{32}S, at t = 0, in proportions leading to the observed abundance of ^{28}Si, ^{30}Si, and ^{31}P was found to lead to the generation of most elements between ^{28}Si and ^{59}Co if one added up the zone where "no" Si had burned, where little had burned... and where all had burned. The summation over the zones was seen to depend on essentially two parameters which most conveniently can be expressed as the lower and upper limits of integration. One then has essentially four parameters: $((N - Z)/(N + Z))_{t=0}$, $\langle A \rangle_{t=0}$, and the two limits of integration. The density was found to have no effect on the results. The temperature is more important but the range of freezing temperatures to be expected can be estimated accurately enough from the dynamic time scale. With four free parameters, one fits the abundances of some 25 to 30 of the 41 nuclei between ^{28}Si and ^{59}Co. Some of the poorly fitted nuclei are very neutron-rich nuclei (^{36}S, ^{40}A, ^{46}Ca, ^{48}Ca) that could easily have been formed by a slight exposure of the material to a neutron flux. (Diss. Abstr. Int., B)

6974 MODEL ATMOSPHERES AND STRONG-LINE PROFILES FOR LATE-TYPE DWARFS. Hershey, John Landis. Charolettesville, Va.; Univ. of Virginia (1969). 164p. University Microfilms Order No. 70-8074.

Thesis.

Twenty nongrey model atmospheres were computed in detail for stars on the lower main sequence. The models form a loose grid ranging from 5200° to 3200° in effective temperature. Eight models used a scaled solar T (τ) relation and seven held the radiative flux constant to within one percent. Five models included the effects of convection by the mixing length theory and the sum of the radiative and convective fluxes was held constant to within a few percent. One of each of the three types was metal deficient and one varied the surface gravity. The effect of line blanketing was not included in the models. (TSS) (Diss. Abstr. Int., B)

6975 VARIATIONAL PRINCIPLE FOR DIFFERENTIALLY ROTATING, RELATIVISTIC STARS. Abramowicz, Marek Artur (Inst. of Astronomy, Warsaw). Astrophys. Lett.; 7: 73-4(Nov 1970).

A relativistic generalization of the Ostriker and Lynden–Bell theorem concerning the extremalization of the total energy of a differentially rotating star with constant total mass (total number of baryons) and constant Lagrangian distribution of angular momentum per baryon is formulated and briefly drafted. The details of the proof and discussion will be given in other papers. (auth)

6976 OH EMISSION AT 1612 MHz FROM VX SAGITTARII. Caswell, J. L.; Robinson, B. J. (Commonwealth Scientific and Industrial Research Organization, Sydney). Astrophys. Lett.; 7: 75-7(Nov 1970).

A search for OH emission from 16 long-period variable stars revealed the 1612-MHz emission characteristic of infrared objects from one of these, VX Sgr. Comparisons are made with the 10 OH infrared sources previously known to emit on the 1612-MHz OH line. (auth)

6977 LINEAR POLARIZATION AND VARIABILITY IN THE OH-EMISSION FROM VY CANIS MAJORIS. Robinson, B. J.; Caswell, J. L.; Goss, W. M. (Commonwealth Scientific and Industrial Research Organization, Sydney). Astrophys. Lett.; 7: 79-84(Nov 1970).

Large changes were observed in the OH emission from VY Canis Majoris at both 1665 and 1667 MHz. The polarization and the intensity of some components of the profiles changed markedly; in one case the polarization changed from predominantly circular to predominantly linear. (auth)

6978 RADIO STRUCTURE OF NGC 7027. Webster, William J. Jr. (National Radio Astronomy Observatory, Green Bank, W. Va.); Wink, Joern E.; Altenhoff, Wilhelm J. Astrophys. Lett.; 7: 47-9(Nov 1970).

The planetary nebula NGC 7027 was mapped at 11.1 cm with the NRAO 2.7-km interferometer. The radio nebula appears to have a simple Gaussian-like structure with half-power widths 7.0 × 5.1 arc sec. Model calculations show that the radio source contains 0.21 $M_\odot$ of ionized hydrogen and has an electron density at least as high as 3.8×10^4 cm^{-3}. (auth)

6979 STABILITY OF ISOTROPIC NEWTONIAN STAR CLUSTERS. Fackerell, Edward D. (California Inst. of Tech., Pasadena). Astrophys. J.; 162: 1053-4(Dec 1970).

The conjecture that all isotropic, spherically symmetric equilibria of Newtonian star clusters for which the distribution function is a decreasing function of energy are stable is discussed. It

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is shown that the use of Ipser's trial function can never lead to the prediction of an instability. (auth)

6980 INSTABILITY OF MAGNETOHYDROSTATIC STELLAR INTERIORS FROM MAGNETIC BUOYANCY. I. Gilman, Peter A. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 162: 1019-29(Dec 1970).

It is shown that magnetic buoyancy gives rise to a normal-mode instability in fluids in magnetohydrostatic balance whose diffusivity of heat is large compared with viscosity and magnetic diffusivity, such as in stellar interiors. In an unbounded compressible fluid acted upon by external gravity containing a straight horizontal magnetic field, the instability occurs if the magnetic field decreases with height. The unstable modes are narrow cross-section loops of magnetic field and matter whose finite wavenumber k along the magnetic field lies in the range $0 < k^2 < -(g/S^2)\,\partial/\partial z \ln \bar{B}$, where $\bar{B}(z)$ is the basic magnetic field, g is gravity, and S is the isothermal sound speed. Thus, in a star with a toroidal magnetic field, this would be a nonaxisymmetric instability. A detailed analysis is made of the special case in which the Alfvén and sound speeds are independent of height and which thus elucidates the role of magnetic buoyancy. Sufficiently large rotation perpendicular to gravity is shown to be stabilizing in this case. The instability simultaneously releases potential and magnetic energy, through downward transport of mass and upward transport of magnetic flux, respectively. The instability gives a mechanism by which magnetic flux may be expelled from stellar interiors. (auth)

6981 MAIN-SEQUENCE PHOTOMETRY, COLOR–MAGNITUDE DIAGRAMS, AND AGES FOR THE GLOBULAR CLUSTERS M3, M13, M15, AND M92. Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 162: 841-70(Dec 1970).

New photoelectric photometry is reported for four globular clusters. Distance moduli were found by using nearby field subdwarfs with trigonometric parallaxes for calibration, with account taken of the ultraviolet excess. If one excludes M13, whose RR Lyrae stars may be related to the asymptotic branch rather than the horizontal branch, the RR Lyrae stars in M3, M15, and M92 have $\langle M_V \rangle \simeq +0.06 \pm 0.2$ by this method. The mean is close to values obtained by Woolley et al. and van Herk from statistical parallaxes, and by Christy from pulsation theory. Christy's calculations of absolute magnitudes are consistent with the Oosterhoff–Sawyer effect, and are adopted as a more precise method to obtain luminosities at the termination of the main sequence. Final adopted moduli are $(m - M)_{0,M3} = 14.83$, $(m - M)_{AV,M13} = 14.42$, $(m - M)_{0,M15} = 14.93$, and $(m - M)_{AV,M92} = 14.63$, where the subscripts zero and AV mean true and apparent visual moduli, respectively. The adopted turnoff luminosities and the helium and metal abundances used for age dating are listed. Ages calculated from Iben and Rood's models average 11.5×10^9 years and have a very small spread. Ages from models by Demarque et al. are about 20% smaller. These ages show no major conflict with limits for the Friedmann time of the expanding Universe when the present uncertainties in the Hubble constant and the deceleration parameter are considered. The well-known correlation of the Oosterhoff–Sawyer period-groups with metal abundance is shown to be a natural consequence of the prediction of Simoda and Iben that for clusters of equal age, those with lower metal abundance have brighter luminosities at main-sequence turnoff. The observations and theory are combined to show that the most probable age spread among the four clusters is $\Delta T/T \simeq 0.014$ or $\Delta T \simeq 1.5 \times 10^9$ years as required in the rapid-collapse picture of the Galaxy discussed by Eggen, Lynden-Bell, and Sandage. But the limiting error of the result is high, and permits limits of about $\Delta T \simeq 10^9$ years for the age spread. Representative points of the C–M diagrams for the four clusters are tabulated. (auth)

6982 Hα AS A TEMPERATURE INDICATOR IN CEPHEIDS. Schmidt, E. G. (Australian National Univ., Canberra). Astrophys. J.; 162: 871-81(Dec 1970).

The gross behavior of the Hα profile was examined for a number of Cepheids, and it was found that large distortions occur only for stars with $\langle (B - V)^0 \rangle$ redder than about 0.80. A comparison was made between the wings of the measured profiles of four Cepheids and a series of newly computed profiles in order to determine whether the temperature variations can be studied in this way. For two of the stars, η Aql and S Nor, it was found that the profiles do not agree well and the resulting temperature curves differ in shape from the color curves during the later part of descending light and during ascending light. For the other two stars, U Sgr and Y Oph, the profiles agree during the entire cycle and the temperature curves determined agree in shape with the color curves. (auth)

6983 SUPERMETALLICITY OF THE MAIN-SEQUENCE STARS IN M67 AND NGC 188. Spinrad, Hyron (Univ. of California, Berkeley); Greenstein, Jesse L.; Taylor, Benjamin J.; King, Ivan R. Astrophys. J.; 162: 891-904(Dec 1970).

To investigate the metal abundances of unevolved main-sequence stars in old open clusters, the interstellar reddening in M67 and NGC 188 was redetermined by two new techniques. Results were E(B−V) from 0.11 to 0.09 mag for M67 and E(B − V) about 0.15 mag for NGC 188, higher than the reddening values suggested by the photometry of Eggen and Sandage. The Na D-lines in four main-sequence late F stars in M67 were also scanned with an effective resolution of 14 Å; the D-lines are strong—well above the Hyades level. It was found that $[Na/H]_\odot = +0.5$ to $+0.6$ for these M67 F dwarfs. Fagerholm 81, the B7 V star in M67, has a strong Mg II λ4481 line; for this star, $[Mg/H]_\odot = +0.6$. It has normal helium. Classification of low-dispersion spectra shows spectral anomalies of turnoff-point stars in both M67 and NGC 188. Metallic lines yield later types than do Hδ and Hγ; the index of spectral peculiarity $\langle \Delta S \rangle = -4$ for M67 and $\langle \Delta S \rangle = -6$ for NGC 188. The negative ΔS indices are strongly suggestive of supermetallicity, the NGC 188 stars being more extreme. The paper concludes with a discussion of the validity of the classical interpretation of small ultraviolet excesses in two-color diagrams of open clusters. (auth)

6984 EXPANDING ENVELOPE AROUND THE SYSTEM UPSILON SAGITTARII. Sahade, Jorge; Albano, Jorge (Observatorio Astronomico, La Plata). Astrophys. J.; 162: 905-8(Dec 1970).

Evidence is presented for the existence of an expanding envelope around the system ν Sgr. (auth)

6985 TEMPERATURE DEPENDENCE OF Hβ STRENGTH IN O STARS. Zinn, Robert J. (Yale Univ., New Haven). Astrophys. J.; 162: 909-12(Dec 1970).

Photoelectric observations of sixteen O stars show that the equivalent width of Hβ is nearly constant from B0 V to O5. This result supports the non-LTE model-atmosphere computation of Mihalas and Auer. (auth)

6986 SCHUSTER'S EMISSION-LINE MECHANISM. Harrington, J. Patrick (Univ. of Maryland, College Park). Astrophys. J.; 162: 913-18(Dec 1970).

Schuster's mechanism is reexamined for the case of a gray atmosphere, and the conditions under which emission can occur are given. No strong lines are expected to appear in emission, although this mechanism could contribute to emission in line wings under extreme conditions. (auth)

6987 SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. XVIII. THE BRIGHT, INTERMEDIATE-EXCITATION PLANETARY NGC 6210. Aller, L. H. (Univ. of California, Los Angeles); Czyzak, S. J.; Buerger, Edith G. Astrophys. J.; 162: 783-7(Dec 1970).

The amorphous planetary NGC 6210 has a sufficiently high surface brightness so that its spectrum may be studied in some detail. Mount Wilson and Lick coudé plates combined with photoelectric photometry yield intensities of 122 lines of ions of H, He I, He II, C II, C III, N III, O II, [O II], O III, [O III], [F IV]? Ne II, [Ne III], Mg II, Si IV, [S II], [S III], [Ar IV], and [Fe V]. (auth)

6988 PRESSURE IONIZATION IN WHITE-DWARF CONVECTION ZONES. Boehm, K. H. (Univ. of Washington, Seattle). Astrophys. J.; 162: 919-23(Dec 1970).

Outer convection zones of cool white dwarfs ($5790°K \leq T_{eff} \leq 9000°K$) were studied, with pressure ionization and partial degeneracy taken into account. H and He I become completely pressure ionized, and He II partially so, within the convection zone. This effect leads to a drastic lowering of the adiabatic gradient in white dwarfs with $T_{eff} < 8000°K$ and to a further lowering (as compared with earlier estimates) of the core temperature of white dwarfs of a given effective temperature. (auth)

6989 REDISCUSSION OF ECLIPSING BINARIES. IX. TX HERCULIS AND ZETA PHOENICIS. Popper, Daniel M. (Univ. of California, Los Angeles). Astrophys. J.; 162: 925-32(Dec 1970).

New spectrographic material for these two systems with unequal main-sequence components shows that the earlier determinations of their masses and radii require appreciable downward revisions. The new results are contained in a table. TX Her displays the same discrepancy between surface-brightness ratio and color difference as was found for the similar systems CM Lac and V477 Cyg. Photometry on a standard color system is required for ζ Phe. (auth)

6990 EFFECT OF COMPOSITION ON THE POST-RED-GIANT EVOLUTION OF A 5 $M_\odot$ STAR. Hallgren, E. L.; Cox,

J. P. (Joint Inst. for Lab. Astrophysics, Boulder, Colo. Univ. of Colorado, Boulder). Astrophys. J.; 162: 933-8(Dec 1970).

Calculations are presented of the evolution of three 5 $M_\odot$ stellar models from main sequence through core-helium exhaustion. The compositions of the three models are Y = 0.30, Z = 0.03 (Population I); Y = 0.20, Z = 0.03 (helium poor); Y = 0.30, Z = 0.015 (metal poor). The main purpose of the calculations was to examine the effect of composition on the loops in the H–R diagram during core-helium burning, by the use of three compositions instead of only two (as previous investigations have done). It was found that (1) the existence of the loops appears to be independent of composition; (2) the blue end of the loop becomes cooler and brighter as Y increases (at constant Z) and cooler and fainter as Z increases (at constant Y). Comparison with previous calculations suggests that the detailed properties of the calculated loops depend more strongly on the computational methods and assumptions than on the composition. (auth)

6991 MODELS FOR PARTIALLY MIXED STARS. Rood, Robert T. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 162: 939-46(Dec 1970).

Theoretical models were obtained for stars in which part of the hydrogen-rich envelope has been mixed into the helium core at the time of helium flashing. The effects of varying the degree of mixing, the extent of carbon production at the flash, and the total stellar mass were determined. While burning hydrogen at the center, mixed stars evolve in the region just above the subgiant branch. After hydrogen exhaustion at the center, evolution proceeds parallel to but somewhat to the blue of the giant branch; however, helium ignition now takes place under nondegenerate conditions, and no second flash occurs. In some cases the structure of the star is then almost identical with one which had undergone no mixing at the first flash; and evolution proceeds in the region of the horizontal branch. During the phase in which hydrogen is burned in the core, many of the models lie in the region of the H–R diagram occupied by the blue stragglers observed in M3. It is suggested that similar models may be appropriate for blue stragglers and pseudo-horizontal-branch stars in old open clusters. Present observational evidence does not distinguish this from alternative explanations. (auth)

6992 UPPER MASS LIMIT FOR MAIN-SEQUENCE STARS. Ziebarth, Kenneth (Joint Inst. for Lab. Astrophysics, Boulder, Colo. Univ. of Colorado, Boulder). Astrophys. J.; 162: 947-62 (Dec 1970).

Two aspects of the problem of the upper mass limit were investigated. First, a linear nonadiabatic analysis was used to investigate the dependence of this limit on composition. Second, a nonlinear hydrodynamic calculation was carried out to study the consequences for a star whose mass exceeds the limit. The maximum stable mass was not found to be a sensitive function of composition. This mass, M_c, decreased with increasing Y at fixed Z; at fixed Y, M_c decreased with decreasing Z. In the hydrodynamic calculation it was necessary to increase artificially the very slow growth rate of the pulsations. After initiation of small-amplitude pulsations in the fundamental mode, the pulsations grew to a limiting amplitude too small to produce mass loss. It is shown that the artificial increase in growth rate probably greatly underestimates the shock-wave dissipation. If this is true, mass loss may never occur. Instead, stars with masses above the stability limit may simply pulsate at some (perhaps small) amplitude until nuclear evolution stabilizes them. (auth)

6993 NONRADIAL OSCILLATIONS OF WHITE DWARFS, HOT WHITE DWARFS, AND 10 $M_\odot$ MODELS. Harper, Ronald Van R.; Rose, William K. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 162: 963-9(Dec 1970).

Solutions to the Pekeris equation for nonradial oscillations were obtained for white dwarfs, hot white dwarfs, and 10 $M_\odot$ models. Solutions for polytropic models are presented for comparison with previous calculations. Two astronomical applications of the present calculations are considered. The first is concerned with the conditions necessary for excitation of nonradial oscillations in white dwarfs and hot white dwarfs that are unstable to radial pulsation. The second application is concerned with the occurrence of double periodicity that is observed for a number of β CMa variables. The calculations indicate that when 10 $M_\odot$ models have evolved to about 1 mag above the main sequence, their pulsation periods are comparable to those of β CMa variables. In addition, the fundamental radial mode and the l = 2 Kelvin mode are still nearly in resonance. The calculations support the suggestion of Chandrasekhar and Lebovitz that the observed double periodicity is due to a near degeneracy between these modes. (auth)

6994 ADIABATIC PULSATIONS FOR COLD SPHERES OF LOW MASS. Vila, Samuel C. (Univ. of Pennsylvania, Philadelphia). Astrophys. J.; 162: 971-3(Dec 1970).

The adiabatic pulsation periods and eigenfunctions of zero-temperature spheres of low mass were calculated. The models used are constructed by using an equation of state derived by Salpeter and Zapolski. The range of masses considered extends from 0.3 $M_\odot$ to less than 0.001 $M_\odot$. The calculations were performed for pure-hydrogen and pure-helium models. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

6995 OPTICAL VARIABILITY OF 3C 345. Smyth, M. J.; Wolstencroft, R. D. (Univ. of Edinburgh). Astrophys. Space Sci.; 8: 471-7(Sep 1970).

Photographic observations of the quasar 3C 345 during 1968 and 1969 are reported. They show a quiescent state during 1968 and renewed activity in 1969. Fourier analysis of all available brightness measurements 1965–69 shows a dominant long-term variation with an apparent period of 1025 d, and two weak components with periods of 165 and 556 d. There are no conspicuous short-period components down to 10 d. The light curve synthesized from these three components does not fully represent the rapid variations, but does suggest a period of 165 d for the optical spikes, which is probably related to the periods of 80 and 320 d suggested earlier. (auth)

6996 DISTRIBUTION OF PULSAR PERIODS AT DIFFERENT GALACTIC LATITUDES. Ryynaenen, Lauri (Univ. of Oulu, Finland). Astrophys. Space Sci.; 8: 497-501(Sep 1970).

Pulsars at different galactic latitudes have different periods. It seems possible that there are two different types of pulsars. (auth)

6997 MODEL FOR THE RADIATIONS FROM THE COMPACT STRONG SOURCES. Cavaliere, A. (Massachusetts Inst. of Tech., Cambridge. Laboratorio Gas Ionizzati, Frascati, Italy); Morrison, P.; Pacini, F. Astrophys. J.; 162: L133-8(Nov 1970).

A rough but consistent model for the origins and time variations of the radiation spectrum of a compact source over all wave bands is presented. The example discussed is 3C 273B; other active galactic nuclei are included by extension. Primary synchrotron emission is in the infrared; its low-frequency decline is due to the cyclotron turnover. Optical and x-ray continua are Compton-recoil photons; the radio outbursts arise in the familiar expanding clouds. The dynamical model which naturally fits the requirements is that of a condensed, rotating, magnetized body that is evolving nonthermally. (auth)

6998 INVESTIGATION OF THREE DISCRETE COSMIC X-RAY SOURCES IN THE SCORPIUS–ARA REGION. Palmieri, Thomas Michael. Madison, Wis.; Univ. of Wisconsin (1969). 102p. University Microfilms Order No. 70-3654.

Thesis.

Three discrete sources of celestial x rays were observed with a detector system sensitive to low-energy (.15 to 8 keV) x rays. The data were obtained during the flight of an unguided Aerobee 150 sounding rocket, launched 03:45 U.T., September 21, 1968, from White Sands Missile Range, White Sands, New Mexico. (TSS) (Diss. Abstr. Int., B)

6999 RADIO RECOMBINATION LINES FROM DIFFUSE INTERSTELLAR GAS. Gottesman, S. T.; Gordon, M. A. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 162: L93-7(Nov 1970).

Observations at three galactic longitudes close to the galactic plane and free from H II regions of high surface brightness show H157α (λ18 cm) lines having peak antenna temperatures of 0.05°K and velocity extents as large as 130 km s^{-1}. Assumptions about the thermal fraction of the galactic background radiation permit us to place constraints on the kinetic temperature, emission measure, and electron density of the ionized medium. These spectra are compared with those from neutral atomic hydrogen (λ21 cm), and some initial comments are made about the dynamics and distribution of this medium. (auth)

7000 OPTICAL IDENTIFICATION OF THE VELA PULSAR. Chiu, Hong-yee (Goddard Inst. for Space Studies, New York); Lynds, Roger; Maran, Stephen P. Astrophys. J.; 162: L99-101 (Nov 1970).

The results of attempts to find the optical counterpart of the radio pulsar PSR 0833–45 in Vela are presented. The observational material consists of phase-selective image-tube photographs of the field surrounding the radio position of this pulsar and a time-averaged summation of the photographic material. Attention is called to a faint star near the radio position of the pulsar, and an improved upper limit is derived for pulsed optical emission. (auth)

XUM

7001 OPTICAL IDENTIFICATION OF THE VELA PULSAR: PHOTOELECTRIC MEASUREMENTS. Kristian, Jerome (California Inst. of Tech., Pasadena). Astrophys. J.; 162: L103-4 (Nov 1970).

A limit of $V \geq 24$ is given for the visible pulsed emission of the Vela pulsar. The evidence for the distance and interstellar absorption of the pulsar is reviewed, and its absolute visible luminosity is estimated to be more than 4000 times fainter than that of the Crab pulsar. This is the 8.4 power of the ratio of rotation frequencies, and 100 times fainter than the fourth power of the same quantity. (auth)

7002 MEASUREMENTS OF PULSAR ARRIVAL TIMES. Hollinger, J. P. (Naval Research Lab., Washington, D. C.); Hevey, R. H.; Knowles, S. H.; Sadeh, D.; Youmans, A. B. Astrophys. J.; 162: L105-7(Nov 1970).

The pulse arrival times of five pulsars were observed over a period of 1 year. Originally the experiment was undertaken as an attempt to test the general theory of relativity. However, residuals in the measured arrival times are too large to allow a test of the general theory of relativity. As an alternative, relativity was assumed; and the positions, period, and rates of change of period of the pulsars were determined. (auth)

7003 X-RAY AND OPTICAL VARIATIONS OF SCORPIUS X-1. Evans, W. D. (Los Alamos Scientific Lab., N. Mex.); Belian, R. D.; Conner, J. P.; (and others). Astrophys. J.; 162: L115-19(Nov 1970).

Satellite measurements of the x-ray intensity of Sco X-1 are presented for two periods of approximately 4 hours each. On August 2, 1969 simultaneous optical and x-ray observations (at 3 to 12 keV) were made during an optical flare. The x-ray flux at the time of the flare was at least a factor of 2.5 greater than the preflare minimum. On October 17, 1969 large and rapid changes in the x-ray intensity were observed with identical detectors on two Vela 5 satellites. The variations in x-ray flux during this time were similar to the fluctuations in optical brightness that have been reported. (auth)

7004 CONTINUAL VARIATIONS IN THE HIGH-ENERGY FLUX OF X RAYS FROM SCORPIUS X-1. Lewin, Walter H. G.; McClintock, Jeffrey E.; Ryckman, Stanley G.; Glass, Ian S.; Smith, William B. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 162: L109-13(Nov 1970).

On March 20, 1969 balloon x-ray observations of Sco X-1 (>18 keV) from Australia were carried out and the intensity was found to fluctuate continually between 16:30 and 21:30 U.T. Changes of factors of 2 or more in intensity were observed within time intervals of $\frac{1}{2}$ to 1 hour. (auth)

7005 INVERSE COMPTON EFFECT FOR POWER-LAW RADIATION SCATTERED BY RELATIVISTIC ELECTRONS WITH A POWER-LAW SPECTRUM. Charugin, V. M. (Inst. for Space Research, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 531-2 (Nov-Dec 1970).

Translated from Astron. Zh.; 47: 664-6(May-Jun 1970).

The expression for the Compton-scattering cross section is generalized to the case where the energy of the scattered photon is less than the energy of the incident photon. An expression is obtained for the radiation flux when relativistic electrons scatter their own synchrotron radiation. (auth)

7006 PULSARS AND NONTHERMAL RADIO SOURCES. Kardashev, N. S. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 375-84(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 465-78(May-Jun 1970).

The physical phenomena occurring in galactic and extragalactic sources of nonthermal radio emission are discussed under the assumption that pulsars are the primary sources of magnetic fields and cosmic rays. A system of equations is derived for the behavior of a supernova envelope immediately after the explosion and at later times. The structure of the magnetic fields of supernova and pulsar envelopes is discussed. The mechanism for the pulsed radio emission of a pulsar is treated as the nonlinear conversion of low-frequency emission with a period equal to the pulsar rotation period. The pulse characteristics predicted are compared with those observed, and further experiments are proposed for verifying this mechanism. Propagation of radio waves in a pulsar magnetosphere, the associated Faraday rotation of the plane of polarization, and signal retardation are discussed. It may be possible to observe pulsars after supernova explosions in nearby galaxies. A method based on the assumption that extragalactic radio sources are clusters of objects similar to the Crab Nebula is proposed for determining the number of pulsars in a cluster. (auth)

7007 SPECTRUM OF RELATIVISTIC PARTICLES ACCELERATED BY PLASMA TURBULENCE. Tsytovich, V. N.; Chikhachev, A. S. (Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 385-7(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 479-82(May-Jun 1970).

The spectra of particles accelerated by high-frequency plasma turbulence are analyzed. It is shown that these are power-law spectra, and the spectral exponent is analyzed. Solution of the equation for γ has a singularity at $\gamma = 2.7$ corresponding to the observed cosmic-ray spectra. At this point, large changes in intensity exert virtually no change in γ. In the general case, $0.9 < \gamma < 3$, which corresponds to the observed spectral indices of cosmic radio emission. (auth)

7008 RELATION BETWEEN THE PULSAR NP 0532 AND THE SMALL-ANGULAR-SIZE RADIO SOURCE IN THE CRAB NEBULA. Matveenko, L. I.; Lotova, N. A. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 388-90 (Nov-Dec 1970).

Translated from Astron. Zh.; 47: 483-6(May-Jun 1970).

It is shown on the basis of the spectrum and pulse duration of the pulsar NP 0532 that the small-angular-size radio source situated in the central part of the Crab Nebula may possibly be the pulsar and its magnetosphere. On the basis of the amount of polarization–plane rotation in the nebula's radio emission, and from the integral number of electrons along the line of sight, the relative position of the pulsar is estimated. With an accuracy within the error of determination of medium and nebular envelope parameters, the pulsar is located inside the nebula. Also, the size of the pulsar in the remains of the outburst of the supernova Vela X is estimated. (auth)

7009 PRECISE POSITIONS OF RADIO SOURCES. I. RADIO MEASUREMENTS. Wade, C. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 162: 381-90 (Nov 1970).

The positions of forty-six radio sources were measured with the NRAO three-element interferometer by a self-calibrating technique that gives an absolute determination of the declinations. The results are believed to be accurate to better than 1″ in most cases. (auth)

7010 SPACE DISTRIBUTION AND LUMINOSITY FUNCTIONS OF QUASARS. Schmidt, Maarten (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 162: 371-9(Nov 1970).

Redshifts of an essentially complete sample of optically selected quasi-stellar objects are used to derive their distribution in space and the optical luminosity function. The number per comoving volume element varies as $(1 + z)^6$, similar to the density law derived for 3CR quasi-stellar radio sources. The optical luminosity function rises toward fainter absolute magnitudes by a factor of around 3 per magnitude. The local space density is of the order of 10^{-6} Mpc^{-3}. It is proposed that the radio luminosity function depends on the optical luminosity in such a manner that the ratio has a universal distribution function. The predicted relation between number and radio flux density for quasi-stellar sources is similar in shape to that observed for extragalactic sources. (auth)

7011 SYNTHESIS OF THE POLARIZATION PROPERTIES OF 3C 10 AND 3C 58 AT 1420 AND 2880 MHz. Weiler, Kurt Walter. Pasadena, Calif.; California Inst. of Tech. (1970). 131p. University Microfilms Order No. 70-12,501.

Thesis.

An earth rotation aperture synthesis technique was combined with the methods of interference polarimetry to study the total intensity and polarization properties of the two radio sources 3C 10 and 3C 58 with a resolution of approximately one minute of arc at both 1420 and 2880 MHz. These data were then used to calculate the spectral index, rotation measure, intrinsic position angle, and depolarization distributions for the two sources. Source models were constructed and estimates obtained for the internal magnetic field strength and relativistic electron density. The origins of the rotation measure and depolarization were studied and estimates of the internal thermal electron density obtained. Attempts were made to compare the present results with the several theories of supernova remnants. 3C 10, the remnant of a Type I supernova, in the total radiation is an annular source with a sharp outer edge and little emission from the central regions. The polarized flux density distribution has a similar, but less well defined, ring shape which exhibits a relatively high degree of polarization in many areas. The intrinsic position angle distribution implies a radial component of the magnetic field. 3C 58, also believed to be the remnant of a Type I supernova, has a simple shape in the total radiation, brightest in the center and falling off slowly

to zero on the edges with an elongation in the east–west direction. The polarized emission shows considerable structure having many areas with relatively high degrees of polarization. The intrinsic position angle distribution implies the existence of a component of the magnetic field lying parallel to the major east–west axis over the full extent of the source. (Diss. Abstr. Int., B)

7012 SOME PROBLEMS IN THE THEORY OF RADIO SOURCES AND PLANETARY NEBULAE. Walmsley, Charles Malcolm. San Diego, La Jolla, Calif.; Univ. of California (1969). 156p. University Microfilms Order No. 70-11,948.

Thesis.

Current theories to explain the variable centimeter radio sources are discussed. Sample spectra are calculated for a few situations which might be expected to arise. In particular, the effects of synchrotron self absorption and Compton scattering in young compact sources are calculated in detail. The general conclusion is that relativistic electrons are being injected into these sources long after the initial outburst. Also, it is likely that it will be possible to observe Compton scattered radio photons in the optical and x-ray range. The results of a calculation on Lyman-line transfer are given. It is concluded that high Lyman lines in planetaries may be observable. Emergent fluxes and profiles are calculated for Lyman α-10 as well as the run of line intensity with radius. (Diss. Abstr. Int., B)

7013 PRECISE POSITIONS OF RADIO SOURCES. III. COMPARISON OF OPTICAL AND RADIO MEASUREMENTS. Sandage, Allan (Carnegie Institution of Washington, D. C.); Kristian Jerome; Wade, C. M. Astrophys. J.; 162: 399-403(Nov 1970).

Radio and optical positions given in the preceding two papers for forty identified sources are in excellent agreement, which indicates that the technique used in the first paper for measuring radio positions is generally accurate to better than 1″. The radio and optical positions agree, within the combined errors, for thirty-six of the forty sources. The disagreement for the other four sources is less than 1.3 times the combined errors. Comparison with other optical and radio positions of claimed high accuracy shows in all cases that the quoted errors are realistic, with the exception of the optical positions given by Lü and Fredrick. (auth)

7014 MAXIMUM-LIKELIHOOD ESTIMATION OF THE SLOPE FROM NUMBER-FLUX-DENSITY COUNTS OF RADIO SOURCES. Crawford, David F.; Jauncey, David L.; Murdoch, Hugh S. (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.). Astrophys. J.; 162: 405-10(Nov 1970).

The application of the method of maximum likelihood (ML) to the determination of the slope of the number–flux-density distribution of radio sources is discussed. It is shown that the ML estimate of the slope, which uses the maximum available information, may be obtained by a simple calculation from the individual flux densities. The efficiency and bias of other methods are compared with the ML method by means of numerical calculations on simulated data. The error of using integral counts is stressed and an example is given from the literature to demonstrate that incorrect conclusions may be drawn through the use of statistically invalid procedures. The need to test the adequacy of the power-law model is stressed. (auth)

7015 OPTICAL POLARIZATION AND INTENSITY OF THE PULSAR IN THE CRAB NEBULA. Kristian, J. (California Inst. of Tech., Pasadena); Visvanathan, N.; Westphal, J. A.; Snellen, G. H. Astrophys. J.; 162: 475-83(Nov 1970).

Broad-band photoelectric measurements on nine nights between February 1969 and February 1970 show constant intensity and colors for the pulsar of $V = 16.5$, $B - V = +0.5$, $U - B = -0.45$, and $V - R = -0.75$, with an accuracy of 10 to 15% in each passband. The ratio of the intensity in the main pulse to that in the subpulse is about 1.8 in each color, with the same accuracy. In the passband 3800 to 6000, the pulsar intensity repeated within 3% on nights 2 months apart. Measurements of linear polarization on four nights in February, August, and October 1969 show repeatable behavior, with the amount of polarization changing smoothly through the pulse from at least 25% to near zero and the plane of polarization sweeping through 150° during 60° of the pulsar's rotation. The time behavior was similar in the main pulse and the subpulse. The discontinuous change of the pulsar's period in September 1969 had no discernible effect upon the intensity, colors, or polarization of the pulses. It is argued that the observed pulses are due to a fixed, polarized emission pattern which is azimuthally scanned as the object rotates, and the sweep of the plane of polarization is interpreted in terms of a very general geometrical model. If the model is valid, then the projection of the rotation axis of the pulsar on the plane of the sky is found directly from the data, with an ambiguity of 90°, and is either parallel or orthogonal to the integrated magnetic field of the nebula within 20″ of the pulsar. This agreement between the angles of the rotation axis and the magnetic field of the nebula seems too close to be accidental, and implies that the external field, at least in the vicinity of the pulsar, was produced by the pulsar at some stage in its history. (auth)

7016 RADIO EMISSION FROM A TURBULENT PLASMA. Colgate, Stirling A. (New Mexico Inst. of Mining and Tech., Socorro); Lee, Edward P.; Rosenbluth, Marshall N. Contract AT(30-1)-3927. Astrophys. J.; 162: 649-64(Nov 1970).

The theory of the production and transport of photons in a turbulent plasma is developed and applied to the quasi-stellar sources. In the limit $k_{photon} \gg k_{plasmon}$ a Fokker–Planck equation for the photons is derived. This equation is solved for the case of a spherically symmetric medium. In general, the mean energy of the photons which escape the medium increases as the radius of the medium raised to the one-fourth power. This mechanism may account for the fluctuating radio emission of the QSSs. (auth)

7017 PRECISE POSITIONS OF RADIO SOURCES. II. OPTICAL MEASUREMENTS. Kristian, Jerome; Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 162: 391-8(Nov 1970).

Optical positions of forty-one identified radio sources were measured on 48-inch Schmidt plates or, where crowded or faint, on 200-inch plates. Reductions were made relative to an average of twenty-one standard stars within 1° of each source position. Positions of the standards were updated by proper-motion corrections to the epoch of each plate, retaining the equinox of 1950.0. Internal rms errors average 0.3 in each coordinate. The positions, listed in a table, are on the system of the AGK3, which itself is on the FK4 system. Six new optical identifications were made. NRAO 140, PKS 1508–05, and 3C 343 are probably QSSs. The first two are bright ($m_{pg} \simeq 17$, and $m_{pg} \simeq 16$). The image of 3C 343 is exceedingly faint ($V \simeq 22$) and may be connected by a bridge (unconfirmed) to a nearby twenty-first magnitude galaxy, which itself is a member of a small group. The remaining three new identifications (3C 256, 3C 343.1, and NRAO 530) are probably galaxies, with a possibility that the last is in a cluster. Two previously suggested identifications (3C 256, 0056–17) are found to be incorrect. Six fields remain empty brighter than $m_{pg} \simeq 21.0$. Of these, PKS 2127 + 04 is particularly interesting because a cluster of galaxies may be present near the radio position just at the plate limit but so faint as to be unmeasurable on the Schmidt blue plates. No confirmatory 200-inch plates are yet available. (auth)

7018 RADIO OBSERVATIONS OF W58. Felli, M.; Fossi, B. C. Monsignori (Arcetri Astronomical Observatory, Italy). Astron. J.; 75: 1033-8(Nov 1970).

The large-scale structure of the continuum radio emission from the extended radio source W58 was investigated at 408 and 1400 MHz. The radio source was resolved into several components. The nature of each component is discussed by means of its continuum radio spectrum. (auth)

7019 IDENTIFICATION OF 4C SOURCES USING THE 4C RIGHT ASCENSIONS AND ARECIBO DECLINATIONS. Hazard, C. (Inst. of Theoretical Astronomy, Cambridge, Eng.); Jauncey, D. L.; Backer, D. C. Astron. J.; 75: 1039-45(Nov 1970).

A detailed study was made of the optical fields around 72 4C sources. It is shown that an optical identification program based on 4C right ascensions and Arecibo declinations should yield reliable identifications, provided the search area is restricted to ±30 arc sec in right ascension and ±40 arc sec in declination and regions of low star density, for blue stellar objects brighter than 19 mag and galaxies brighter than 18 mag. (auth)

7020 PRECISE DECLINATIONS AND OPTICAL IDENTIFICATIONS OF SELECTED DISCRETE RADIO SOURCES. Moseley, Gerard F.; Brooks, Clinton C.; Douglas, James N. (Univ. of Texas, Austin). Astron. J.; 75: 1015-26(Nov 1970).

A multibeam bandwidth-synthesis interferometer was used to make accurate declination measurements. The instrument is a 245-MHz, 3-km north–south interferometer used with ten 80 × 17 arc min beams spaced 8.5 in declination. Interferometer fringe spacing was 84 arc sec, at the zenith, and root mean square fluctuations of the output record were equivalent to 10^{-26} W m^{-2} Hz^{-1} in a 30-sec integration. Declinations resulting from 400 observations of 143 discrete sources between +54° and −28° are presented. Typical accuracies of a few seconds of arc were attained and verified by a comparison of the declinations with other precise positions, both optical and radio. Using the new declinations, optical identifications are proposed for 27 radio sources: 12 suggested quasi-stellar objects, 13 galaxies, and two whose right-ascension uncertainty allows two or more possible identifications. (auth)

XUM

7021 POLARIZATION OF THE CRAB NEBULA AT 21.1-cm WAVELENGTH. Wright, M. C. H. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 150: 271-8(1970).

Observations of the polarization distribution of the Crab Nebula at 21.1 cm made with the Cambridge Half-Mile telescope with a beamwidth of 47″ × 126″ arc are discussed. Comparisons with the polarization distributions at optical and shorter radio wavelengths enabled the rotation and depolarization to be plotted over the nebula. The polarization at 21.1 cm contains unresolved structure, which can be attributed to Faraday depolarization in the filaments of the nebula. (auth) (UK)

7022 MAPS OF THE DISTRIBUTION OF POLARIZATION IN FIVE RADIO SOURCES AT 21.1-cm WAVELENGTH. Baldwin, J. E.; Jennings, J. E.; Shakeshaft, J. R.; (and others) (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 150: 253-70(1970).

The method of operation of the recently completed Half-Mile radio telescope at Cambridge for the mapping of the linear polarization of continuum sources is described. Polarization maps at 21.1 cm are presented for five sources: 3C 10 (Tycho's SN), 111, 144 (Crab Nebula), 452, and 461 (Cas A). In addition 3C 286 and 405 (Cyg A) were observed. (auth) (UK)

7023 OBSERVATIONS OF NEUTRAL HYDROGEN IN THE GALACTIC PLANE IN THE LONGITUDE INTERVAL -6^0 TO 120^0. Burton, W. B. (Leiden Observatory). Astron. Astrophys., Suppl. Ser.; 2; 261-89(Sep 1970).

The 25-m Dwingeloo telescope was used to obtain 21-cm line profiles in the galactic plane in the range of longitude −6° to 120°. The line profiles are reproduced graphically as Part V of the "Dwingeloo Atlas of 21-cm Profiles." The observations are also presented on two contour maps of brightness temperatures in velocity−longitude coordinates. The terminal positive velocity and the integrated brightness of the profiles are tabulated. The standard reduction procedures applied to Dwingeloo hydrogen-line measurements made since June 1967 are summarized. (auth)

7024 VELOCITY DISTRIBUTION OF NEUTRAL HYDROGEN IN THE REGION l = 43° TO 56°, b = −4.5° TO +4.5°. Burton, W. B. (Leiden Observatory). Astron. Astrophys., Suppl. Ser.; 2: 291-338(Sep 1970).

Profiles of the 21-cm line of neutral hydrogen emission were obtained in the region between (new) galactic longitudes 43° and 56° and latitudes +4.5° and −4.5° using the 25-m radio telescope at Dwingeloo. The observations were made with the intention of studying the distribution and differential motions of hydrogen in the region in which the Sagittarius spiral arm is seen in cross section. The line profiles are reproduced graphically as Part VI of the "Dwingeloo Atlas of 21-cm Profiles." The observations are also presented as contour maps showing isophotes of brightness temperature in the velocity−latitude and velocity−longitude planes. With the aim of numerically isolating fragments of galactic structure and deriving their velocity properties, optical-depth line profiles were resolved as the sum of a number of Gaussian components. The Gaussian representation of each profile is given graphically. Consistent patterns in the galactic structure can be followed over a range of both longitude and latitude. The main results are contained in graphs giving the latitude and velocity distributions for the different features of galactic structure. Some characteristics of the Gaussian-analysis results are pointed out which suggest the necessity of caution in the interpretation of these distributions. The analysis of the region is supplemented with 21-cm absorption spectra obtained in the direction of the H II region W 51 with 140-ft telescope at Green Bank. The strongest features in the absorption spectra correspond to emission features identified in the analysis of the Dwingeloo profiles. The data indicate that W 51 is near gas flowing along the outside of the Sagittarius arm and that this gas is cooler by a factor of two than the gas in the spiral arm itself. (auth)

7025 EXCITATION OF ATOMIC HYDROGEN FROM THE n TO THE n + 1 LEVELS BY ELECTRON IMPACT. Flannery, M. R. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. Lett.; 7: 85-8(Nov 1970).

Cross sections, at low thermal energies relevant to the analysis of the "anomalous" recombination lines observed in the radio-frequency spectrum from H II regions, are presented for the process $e + H(n) \rightarrow e + H(n + 1)$, where H(n) denotes an excited hydrogen atom in one of the levels 20 and 100. The results are compared with those calculated from various approximations. The magnitudes of the cross sections, which show satisfactory agreement with experiment, strongly suggest that the population of the highly excited states of hydrogen (or helium and carbon) is controlled by collisions with electrons rather than with hydrogen atoms. (auth)

7026 HEATING OF GAS IN THE VICINITY OF QUASARS, NUCLEI OF SEYFERT GALAXIES, AND PULSARS BY THE INDUCED COMPTON EFFECT. Levich, E. V. (Inst. of Chemical Physics, Moscow); Sunyaev, R. A. Astrophys. Lett.; 7: 69-72(Nov 1970).

The heating of electrons resulting from induced Compton scattering of low-frequency radiation has an important influence upon the thermal balance of gas in and around compact radio sources, quasars, the nuclei of Seyfert galaxies, and pulsars. (auth)

7027 IDENTIFICATION OF 4C SOURCES WITH QUASI-STELLAR OBJECTS. Jauncey, D. L. (Cornell Univ., Ithaca, N. Y.); Hazard, C. Astrophys. Lett.; 7: 1-6(Nov 1970).

Identifications with quasi-stellar objects are suggested for 49 radio sources from the 4C catalogue. (auth)

7028 OPTICAL FLARES IN THE QUASI-STELLAR RADIO SOURCES PKS 2345-16 AND NRAO 512. Folsom, G. H.; Smith, Alex G.; Hackney, R. L. (Univ. of Florida, Gainesville). Astrophys. Lett.; 7: 15-18(Nov 1970).

Recent photographic photometry of the quasars PKS 2345-16 and NRAO 512 revealed flare-like outbursts on a time scale of a few days. (auth)

7029 DISTORTIONS IN THE LOW-FREQUENCY SPECTRA OF RADIO SOURCES DUE TO INDUCED COMPTON EFFECT. Sunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Astrophys. Lett.; 7: 19-21(Nov 1970).

The induced Compton scattering on thermal electrons of ambient gas must lead to specific distortions in the low-frequency part of the radiation spectrum of radio sources, if their brightness temperature exceeds $kT_b = m_e c^2/\tau_T(1 + \tau_T)$. These conclusions hold even in the case that the optical depth of the source for Thomson scattering is small $\tau_T \ll 1$ and they do not depend on the electron temperature. (auth)

7030 OBSERVATIONS OF CP 1919 AND NP 0532 AT 38 MHz. Bash, F. N.; Bozyan, F. A.; Torrence, G. W. (Univ. of Texas, Austin). Astrophys. Lett.; 7: 39-41(Nov 1970).

Observations of CP 1919 at 38 MHz have allowed a determination of its average energy per pulse, pulse shape, and electron surface density. NP 0532 was not detected at 38 MHz, and an upper limit of the average peak flux density of the pulse is given. (auth)

7031 OBSERVATIONS OF THE ANOMALOUS RECOMBINATION LINES AT λ22 cm IN GALACTIC NEBULAE. Simpson, Janet P. (Univ. of California, Berkeley). Astrophys. Lett.; 7: 43-6(Nov 1970).

The 168α and 211β lines of carbon at 1375.286 MHz and at 1381.104 MHz respectively were observed in Orion A and M 17, and the 168α line was observed in W3. The line strengths and widths are discussed and compared with observations at higher frequencies. (auth)

7032 EMISSION OF THE EXCITED STATE OF OH AT 6035 MHz FROM NGC 6334. Gardner, F. F.; Ribes, J. C.; Goss, W. M. (Commonwealth Scientific and Industrial Research Organization, Sydney). Astrophys. Lett.; 7: 51-3(Nov 1970).

Emission from the F = 3 → 3 transition of the $^2\Pi_{\frac{1}{2}}$, J = $\frac{5}{2}$ state of OH at 6035 MHz was detected from NGC 6334A (G351.4 + 0.7) using the Parkes 210-ft telescope. The center of emission coincides within 1 arc min with that at 18 cm, and the velocities are within the range found at 18 cm. The emission is appreciably circularly polarized across the profile, but the 10-kHz filters employed were inadequate to resolve the features completely. The pattern is similar in some respects to those found at 1667 and 1665 MHz. The F = 2 → 2 transition at 6030 MHz was not found in NGC 6334. There was no positive detection of the 6035 MHz line in four other southern galactic sources investigated. (auth)

7033 ANOMALOUS MICROWAVE RECOMBINATION LINE IN M17. Menon, T. K. (Univ. of Hawaii, Honolulu). Astrophys. Lett.; 7: 55-7(Nov 1970).

The anomalous microwave recombination line near the He167α line was detected in the direction of M17. The circumstances of detection of the line lead one to suggest that it is formed in the H I region surrounding the source. The flux density in the line is about 6.6% of the H167α line, indicating significant departure from local thermodynamic equilibrium. (auth)

7034 RADIOASTRONOMICAL INVESTIGATIONS IN MILLIMETER- AND SUBMILLIMETER-WAVE RANGES. Kislyakov, A. G. (Scientific-Research Radiophysics Inst., Gorky, USSR). Usp. Fiz. Nauk; 101: 607-53(Aug 1970). (In Russian).

Parameters of antennas and receiving equipment used in

radio-astronomical investigations in the millimeter (mm) and sub-millimeter (sub-mm) ranges are surveyed. Bases of methods of ground measurements of cosmic radio radiation on these waves are presented. Possibilities of carrying out ground observations in the sub-mm range are discussed. Results are given from brightness measurements of the quiet Sun in the range of wavelengths from 20 μ up to 16 mm and from observations of sporadic solar radiation at mm wave lengths. Observations of radiations of the Moon and planets and of discrete radio sources at mm and sub-mm wave lengths are discussed. Problems faced in further observations at mm and sub-mm wave lengths are enumerated. 328 references. (tr-auth)

7035 RADIO PULSE SHAPES, FLUX DENSITIES, AND DISPERSION OF PULSAR NP 0532. Rankin, J. M. (Univ. of Iowa, Iowa City); Comella, J. M.; Craft, H. D. Jr.; (and others). Astrophys. J.; 162: 707-25(Dec 1970).

Observations of NP 0532 at frequencies between 65 and 611 MHz are reported. At high frequencies the main pulse is found to be double; the second component and the interpulse are of very short duration ($\lesssim$300 μsec) at 430 MHz. At lower frequencies the pulses become progressively broader until, below about 120 MHz, only one broad pulse is observed. Measurements of the pulsed flux density yield a spectral index of -2.9 ± 0.4 above 150 MHz, but a sharp turnover in the spectrum occurs at about 100 MHz. The law of pulse delay as a function of frequency agrees closely with the tenuous-plasma dispersion relation, and an improved value of the dispersion measure is given. The variation with radiofrequency of the pulse shape and the low-frequency turnover of the pulsed flux density are explained as effects of scattering in the ionized interstellar medium, if one assumes frequency-independent pulse shape and constant spectral index of the source itself. The compact source observed at low frequencies in the Crab Nebula may be the pulsar. (auth)

7036 BALLOON-BORNE STUDIES OF X-RAY EMISSION FROM SELECTED REGIONS IN THE NORTHERN SKY. Webber, W. R.; Reinert, C. P. (Univ. of New Hampshire, Durham). Astrophys. J.; 162: 883-9(Dec 1970).

During the course of a 12-hour balloon flight from Palestine, Texas, on May 10, 1969 with a large-area x-ray telescope, several x-ray sources were observed. These sources included Sco X-1, Cyg X-1, and Cyg X-2, and SN 1572. In addition, a complex-source and/or galactic-disk anisotropy was observed between $l^{II} = 15°$ and $l^{II} = 35°$. Null fluxes from M87, M31, and Jupiter were obtained at levels considerably below previous measurements. Spectral data for the observed sources are presented. (auth)

7037 BOWEN RESONANCE FLUORESCENCE LINES IN QUASI-STELLAR OBJECTS. Bahcall, John N. (Inst. for Advanced Study, Princeton, N. J.); Kozlovsky, Ben-Zion. Astrophys. J.; 162: 789-90(Dec 1970).

It is shown that the Bowen resonance fluorescence lines are expected to be weak in QSOs even if the nebula is photoionized. (auth)

7038 RADIO EMISSION FROM PULSAR MP 0031–07. Huguenin, G. R. (Univ. of Massachusetts, Amherst); Taylor, J. H.; Troland, T. H. Astrophys. J.; 162: 727-35(Dec 1970).

The pulsar MP 0031–07 exhibits a complex pattern of phase modulation that causes the peaks of successive pulses to drift systematically across the average pulse window. The drifting phenomenon generally assumes one of three distinct modes. Remarkably similar behavior was observed in the emission from CP 0808 + 74. These observations place some useful limits on the range of possible pulsar models. (auth)

7039 QUESTION OF QUASI-STELLAR OBJECTS IN CLUSTERS OF GALAXIES AND THE DEFINITIONS OF QUASI-STELLAR OBJECTS AND COMPACT GALAXIES. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 162: 811-13(Dec 1970).

Photographs show that the supposed quasi-stellar objects B264 and Ton 256 have apparent diameters of 6'' and 9'', respectively. Current definitions require these objects to be called compact galaxies. In all cases so far where moderately low redshift quasi-stellar objects have been examined, none have been associated with small clusters of faint galaxies. (auth)

7040 EXTRAGALACTIC PULSARS. Bahcall, John N. (Inst. for Advanced Study, Princeton, N. J.); Rees, Martin J.; Salpeter, E. E. Astrophys. J.; 162: 737-42(Dec 1970).

Newly formed pulsars might be detectable out to distances ~10 Mpc by searching for millisecond optical or x-ray pulses from the sites of newly reported supernovae. (auth)

Solar Phenomena

7041 ABUNDANCES OF ^{3}He AND ^{4}He IN THE INITIAL SUN IMPLIED BY THE KOCHAROV AND STARBUMOV ASSUMPTION. Abraham, Zulema; Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 162: L125-7(Nov 1970).

The assumption that ^{3}He is destroyed in the Sun much more rapidly than it is formed implies that the initial main-sequence abundances by mass of ^{3}He and ^{4}He were at least $X_3 = 0.09$ and $X_4 = 0.33$. The ^{3}He abundance appears to be in clear conflict with observation. (auth)

7042 STUDY OF THE 21-cm LINE IN THE SOLAR NEIGHBOURHOOD. Venugopal, Virinchipuram R. Vancouver, B. C.; Univ. of British Columbia (1969).

Thesis.

A survey of 21-cm line emission at points equally spaced over the entire sky visible from Penticton, British Columbia, was made, and the profiles obtained at the intermediate galactic latitudes were used to determine several of the properties of the distribution of the gas in the solar neighborhood and to study the dynamics of the gas, including the determination of solar motion with respect to gas, the distribution of random velocities, and the departures of gas velocities from circular motion. (Diss. Abstr. Int., B)

7043 STRUCTURE AND EVOLUTIONARY HISTORY OF THE SOLAR SYSTEM. I. Alfven, Hannes; Arrhenius, Gustaf (Univ. of California, San Diego, La Jolla). Astrophys. Space Sci.; 8: 338-421(Sep 1970).

The method for studying the structure and evolution of the solar system is discussed. It is pointed out that theories that account for the origin of planets alone are basically insufficient. Instead, one ought to aim for a general theory for the formation of secondary bodies around a central body, applicable both to planet and satellite formation. A satisfactory theory should not start from assumed properties of the primitive Sun, which is a very speculative subject, but should be based on an analysis of present conditions and a successive reconstruction of the past states. As a foundation for the subsequent analysis, the relevant properties of planets and satellites are presented. The motion of small bodies is influenced by nongravitational forces. Collisions (viscosity) are of special importance for the evolution of the orbits. It is pointed out that the focusing property of a gravitational field (which has usually been neglected) leads to the formation of jet streams. The importance of this concept for the understanding of the comet-meteoroid relations and the structure of the asteroidal belt is shown. A survey is given of the resonances in the solar system and their possible explanation. It is concluded that in many cases the resonances must already be produced at the times when the bodies formed. It is shown that resonance effects put narrow limits on the post-accretional changes of orbits. Tidal effects on planetary spins and satellite orbits are discussed. It is very doubtful if any satellite except the Moon and possibly Triton has had its orbit changed appreciably by tidal effects. The isochronism of planetary and asteroidal spins is discussed, as well as its bearing on the accretional process. The stability of the solar system and upper limits for changes in orbital and spin data is examined. It is concluded that much of the present dynamic structure has direct relevance to the primordial processes. (auth)

7044 APOLLO 11 AND 12 SOLAR WIND COMPOSITION EXPERIMENTS: FLUXES OF He AND Ne ISOTOPES. Geiss, J. (Univ., Bern); Eberhardt, P.; Buehler, F.; Meister, J.; Signer, P. J. Geophys. Res.; 75: 5972-9(1 Nov 1970).

During the Apollo 11 and 12 landings, solar wind ions were collected in a metal foil for periods of 77 min and 18 hours 42 min, respectively. Mass spectrometric analyses of the collected solar wind particles were made in the laboratory and give the following fluxes and relative abundances for the Apollo 11 and 12 exposure periods, respectively: ^{4}He flux: $(6.2 \pm 1.2) \times 10^8$ and $(8.1 \pm 1.0) \times 10^8$ cm^{-2} sec^{-1}; ^{4}He/^{3}He: 1860 ± 140 and 2450 ± 100; ^{4}He/^{20}Ne: 430 ± 90 and 620 ± 70; ^{20}Ne/^{22}Ne: 13.5 ± 1.0 and 13.1 ± 0.6; ^{22}Ne/^{21}Ne: —and 26 ± 12. The differences in the ^{4}He/^{3}He and ^{4}He/^{20}Ne ratios are significant and are interpreted as time variations in the composition of the interplanetary plasma. From He/O ratios reported in the literature, an approximate solar wind O/Ne ratio of 10 is derived. Comparisons of the results of the solar wind composition experiment with data from implanted solar wind particles in lunar soil and with trapped gases in aubritic meteorites indicate a secular variation in the ^{4}He/^{3}He ratio at the solar surface. (auth)

7045 ION ABUNDANCES IN THE SOLAR WIND. Lange, J.; Scherb, F. (Univ. of Wisconsin, Madison). J. Geophys. Res.; 75: 6350-3(1 Nov 1970).

Ion species and their fractional ion abundances in the solar wind are tabulated. Results from theoretical models and Velo satellites are compared for fractional ion abundances of carbon, nitrogen, oxygen, neon, magnesium, and silicon. Results on the solar wind ion composition deduced from Vela data are considered in the processes affecting the ionization structure of the solar wind as it flows outward from the corona. Unambiguous identification of ions in the Vela data is closely connected with studies of the elemental abundances in the corona and solar wind. (J.C.W.)

7046 SOLAR WIND ION COMPOSITION. Holzer, T. E.; Axford, W. I. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 75: 6354-9(1 Nov 1970).

Model energy per charge spectra was calculated of solar wind ions, assuming that the solar wind ionization state is determined in the solar corona. By comparing these calculations with Vela 3A data, it was found that there is some evidence for the presence in the solar wind of ions of the nuclei ^{12}C, ^{14}N, ^{20}Ne, ^{28}Si, ^{32}S, ^{56}Fe, ^{1}H, ^{3}He, ^{4}He, and ^{16}O. It was also found that the shape of the $^{4}He^{+}$ peak could be consistent with the suggestion that $^{4}He^{+}$ solar wind ions are produced through photoionization of neutral helium atoms (Holzer and Axford, 1970), and that an abnormally large abundance of $^{16}O^{+6}$ ions is not necessary to obtain a consistent interpretation of the observational data. (J.C.W.)

7047 DIFFUSION OF HEAVY IONS IN THE SOLAR CORONA. Alloucherie, Y. (Univ. of Maryland, College Park). J. Geophys. Res.; 75: 6899-6914(1 Dec 1970).

The steady-state diffusive motion of ionized atoms (more massive than hydrogen) in the solar corona is investigated theoretically, with special emphasis on relating the flow velocity and density of these ions to the flow properties of the ionized hydrogen background. The basic approach taken is to regard the ions as test particles interacting with the background electrons and protons; an explicit form of the momentum equation for the ions is derived that contains, as parameters, the density, the velocity, and the temperature of the electrons and protons. These parameters are assumed to be unperturbed by the addition of the ions and were obtained from two models of a simpler corona that consists of ionized hydrogen only: the model of E. N. Parker and the model of P. A. Sturrock and R. E. Hartle. The momentum equation is combined with the equation for conservation of mass and was solved to obtain, as a function of distance from the Sun, the flow velocity and density for certain representative species of ions. It is found that the ions diffuse away from the Sun with velocities somewhat lower than the velocity of the background, and that their relative abundance increases gradually and slowly with height. (auth)

7048 19-GIGAHERTZ (1.58-CENTIMETER) SOLAR RADIO BURSTS AS INDICATORS OF PROTON EVENTS. Croom, D. L. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res.; 75: 6940-9(1 Dec 1970).

A study of 19-GHz (1.58-cm) solar radio bursts recorded at the Slough Solar Radio Observatory from July 1967 to June 1969 suggests that they can be used as reliable indicators of proton events and of PCA's, provided that (a) the peak flux increase during the burst is >50% of the pre-burst values, and (b) that the flux enhancement is >10% for longer than 5 min. The warning period, from the time of the burst to the arrival of the first detectable protons in the vicinity of the Earth, ranges from tens of minutes to several hours. There is a further delay of three or more hours to the time of maximum proton flux. Since only one frequency is involved, a proton warning solar radiometer could be fitted to any aeroplane, satellite, or spacecraft to supplement ground observations. (auth)

7049 LONG-TERM INTENSITY VARIATIONS IN THE SOLAR HELIUM II LYMAN ALPHA LINE. Timothy, Adrienne F.; Timothy, J. G. (University Coll., London). J. Geophys. Res.; 75: 6950-8(1 Dec 1970).

A small grazing incidence monochromator on the Oso 4 spacecraft has monitored variations in the absolute intensity of a 10-A band of the solar euv spectrum centered on the helium II Lyman-α line at 304-A during the periods October to December 1967 and June 1968 to December 1969. Measurements were also made during these periods of the absolute intensity of the solar hydrogen Lyman-α line at 1216 A. The instrument was recalibrated after eighteen months in orbit by comparison with sounding rocket spectrometers and showed no loss of efficiency in the helium II mode of operation. The mean observed value of the helium II Lyman-α line intensity was 8.8×10^{9} photons/cm^2/sec (estimated photometric accuracy ±30%) with long-term variations of up to 20% from the mean value and short-term flux increases of up to 25%. The observed value of the hydrogen Lyman-α line intensity remained essentially constant at 3.6×10^{11} photons/cm^2/sec (±30%). Ground-based measurements of solar activity are seen to be poor indicators of the level of the solar euv flux with the general level of the observed helium II Lyman-α line intensity following most closely variations in the relative sunspot number. (auth)

7050 SOLAR RADIATION IN THE EXTREME ULTRAVIOLET AND ITS VARIATION WITH SOLAR ROTATION. Hall, L. A.; Hinteregger, H. E. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res.; 75: 6959-65(1 Dec 1970).

Measurements of solar extreme ultraviolet radiation in the wavelength range 1310 to 270 A have been made from the satellite Oso 3. The flux variation over a solar rotation period was obtained for emission lines representing elements in various stages of ionization. Since no correction need be made for atmospheric absorption, the accuracy of these results is superior to the accuracy of the results we previously obtained with similar instrumentation aboard rocket vehicles. (auth)

7051 ASYMMETRY IN THE DISTRIBUTION OF SOURCES OF SOLAR MICROWAVE BURSTS ON THE SOLAR DISK. Das Gupta, M. K.; Sarkar, S. K. (Univ. of Calcutta). J. Geophys. Res.; 75: 7250-4(1 Dec 1970).

The distributions of sources of different types of solar microwave bursts (at 4995, 8800, and 15,400 MHz) and solar flares, irrespective of class, were statistically investigated for the period November 1966 to September 1969. It was found that both bursts and flares show strong north–south asymmetry. Out of a total of 2281 bursts, 69%, and out of a total 16,765 flares, 64.7% occurred in the solar northern hemisphere. East–west distributions of both phenomena were found to be fairly symmetrical. (auth)

7052 SOLAR RADIO CENTERS AND INTERPLANETARY SECTOR STRUCTURES IN CONNECTION WITH RECURRENT GEOMAGNETIC STORMS. Lapointe, S. M.; Vallee, J. P. (Univ. of Montreal). J. Geophys. Res.; 75: 6991-8(1 Dec 1970).

The superposed epochs method was used to compute the mean geomagnetic activity as given by the Kp indices for ten days before and after the central meridian passage (CMP) across the Sun of centers of activity having given rise to at least two large centimetric type IV solar radio bursts during one passage on the visible hemisphere, termed repetitive (R) centers. Similarities are found in each of the four last-half solar cycles, for a total duration extending from 1949 to 1967, given substantial evidence for a correlation between R centers and recurrent geomagnetic storms. Minimums in geomagnetic activity for the days relative to CMP of R centers for each of the four last-half solar cycles are explained theoretically by the approach near the Earth of a boundary of an interplanetary sector, whereas maximums in the geomagnetic activity are linked theoretically to specific areas on the solar surface, situated one or two days (out of the 27-day solar rotation) behind the leading edge of a unipolar magnetic region (UMR) or its corresponding ghost UMR, having each an associated interplanetary sector structure. These specific areas of the solar surface could well be the so-called M regions responsible for recurrent geomagnetic storms, through the mechanism of interplanetary sector structures. (auth)

7053 ECLIPSE STUDY OF SOFT-X-RAY DISTRIBUTION OVER THE SUN AND OF THE RELATIVE CONTRIBUTIONS OF X RAYS AND UV TO E-LAYER FORMATION. Bomke, Hans A.; Blake, Henry A.; Harris, Arthur K.; Sheppard, Duane J. (Army Electronics Command, Fort Monmouth, N. J.). J. Geophys. Res.; 75: 6980-90(1 Dec 1970).

A simplified model for x-ray distribution over the Sun (based on photographs provided by J. H. Underwood of NASA) was fitted to the changes in electron production rate during the November 12, 1966, eclipse to determine the relative contributions made by diverse solar regions to the formation of the E layer. The production rates were obtained by using Huancayo ionograms and previously determined E-layer recombination coefficient (5.5×10^{-8} cm^3 sec^{-1}). It was found that two active regions covering only 6% of the solar disk accounted for 32% of the electron production. Moreover, by combining the results so obtained with Underwood's analysis of the x-ray photographs, the relative contributions of soft x rays and of extreme ultraviolet to ion production at the E-layer peak were determined. At this intermediate epoch of the solar cycle, 68% of the production rate was found to be due to soft x rays and 32% to ultraviolet. Reduced to solar-minimum conditions, the x-ray contribution would be 54%, a value about midway between the values predicted by the major theories of E-layer formation. In addition, comparison of results with computations made by Widing for coronal sources of x rays made it possible to infer that the temperature in the two active regions was about 3×10^{6} °K. (auth)

7054 CALCIUM K-LINE FORMATION IN A NONHOMOGENEOUS SOLAR ATMOSPHERE. Beebe, Herbert Alonzo. Bloomington, Ind.; Indiana Univ. (1969). 122p. University Microfilms Order No. 70-12,400.

Thesis.

In the solar spectrum emission features are observed in the cores of the resonance lines of singly ionized calcium. This thesis is a theoretical study of the formation of these intensity reversals in the solar chromosphere, applying a detailed theory of line formation and, by comparison between theoretical and observational results, an evaluation of solar atmospheric models. (TSS) (Diss. Abstr. Int., B)

7055 CONSTANCY OF THE TEMPERATURE IN THE CO MOLECULE LAYER OF THE SOLAR ATMOSPHERE. Sitnik, G. F.; Polonskii, V. V. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 413-15(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 516-19(May-Jun 1970).

Equivalent widths of first-overtone lines of the CO molecule in the range 23,000 to 24,000 Å were measured on tracings of spectra obtained with the ATB-1 solar tower telescope of the Shternberg Astronomical Institute. Assuming a thin CO molecule layer in the solar photosphere, it is found that the temperature remains constant to the accuracy with which the equivalent-width ratios are determined. In accordance with previous results the temperature of this layer may be taken to be 4920 ± 290°K. (auth)

7056 DETERMINATION OF THE AZIMUTHAL ELECTRIC CURRENTS IN THE SURFACE LAYERS OF SUNSPOTS. Jakimiec, J. (Univ. of Wroclaw). Sov. Astron. AJ (Engl. Transl.); 14: 416-25(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 520-32(May-Jun 1970).

The problem of determining the values of the magnetic force in the vicinity of a sunspot from measurements of the magnetic field is discussed. It is convenient to treat the problem as one of determining the electric currents in the spot; the principal difficulty then involves finding the azimuthal component j_φ of the current. A method is developed for determining j_φ by solving a boundary-value problem for differential equations assuming an axisymmetric magnetic field, with the measured field strength serving as the boundary condition. To ensure that the solution will be unique an assumption is made regarding the distribution of the magnetic force F in the neighborhood of the spot being considered: the force is assumed to decline rapidly with height. Calculations of this kind are performed for Stepanov and Gopasyuk's field measurements. The current j_φ that is obtained is located in the penumbral region and extends some distance beyond the spot. The maximum density of this current falls in the range 0.03 to 0.13 A/m^2. An estimate is made for the accuracy of the magnetic-field measurements in the spot such that currents j_φ of this intensity may be reliably determined: in the penumbral region the errors of measurement of the individual field components should not exceed ±50 gauss, while in the umbra they may be larger, up to ±300 gauss. The results of these calculations are analyzed to ascertain how greatly the simplifying assumptions of the method limit the quality of the information obtained regarding the azimuthal-current distribution. The analysis indicates that the method proposed can yield valuable information on the j_φ distribution, and thereby the magnetic-force distribution, in the surface layers of sunspots. (auth)

7057 OBSERVATIONS OF SUNSPOT MAGNETIC FIELDS: TWO NEW EFFECTS. Chistyakov, V. F. (Ussuriisk Solar Station, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 426-31(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 533-40(May-Jun 1970).

Results are reported of measurements of the magnetic splitting of the 6302.508 Å Fe I line on 306 spectrograms of 59 sunspots obtained at Ussuriisk during 1968–1969. In contrast to the customary method the magnetic splitting was measured separately in spectra with right- and left-hand circular polarization. Two new magneto-optical effects are described: (1) a shift in the circularly polarized components of the Zeeman triplet along the wavelength scale; (2) unequal values of the magnetic splitting in spectra with different types of circular polarization. In the first effect the direction of the shift in the Zeeman triplet depends on the sign of the magnetic field and the type of circular polarization of the radiation: in the spectrum of a spot of north magnetic polarity the right-circular components of the Zeeman triplet are shifted toward the violet and the left-circular components toward the red; for a spot of south polarity the directions are reversed. The amount of the shift ranges between 0% and 50% of the amount of magnetic splitting. The second effect, unequal magnetic splitting, obeys the following rule in sunspot cores: for spots of north magnetic polarity the magnetic field strength in spectra with right-circular polarization is greater than in spectra with left-circular polarization; for spots of south polarity the situation is reversed. Measurements of spectra with differing senses of circular polarization may sometimes yield differences in the field strength H as great as 700 to 1000 gauss. If H is measured by the customary method, in which both these effects are neglected, it will systematically be underestimated. The underestimate of H may occasionally reach values of about 1000 gauss for spots having fields of strength 2000 to 4000 gauss. To eliminate the influence of both magneto-optical effects, H should be measured separately in spectra with right- and left-hand circular polarization. (auth)

7058 FLUCTUATIONS IN THE MONTHLY WOLF NUMBERS. Muzalevskii, Yu. S.; Zhukov, L. V. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 432-9(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 541-50(May-Jun 1970).

Several problems involved in determining and analyzing the fluctuations in the Wolf numbers are discussed. A histogram is obtained for the amplitude distribution of the fluctuations. The curve for the moving rms deviations of the fluctuations is shown to reproduce the cyclic properties of the curve for the Wolf numbers smoothed by the Whittaker operator. The spectral density of the autocorrelation function exhibits very nearly the same behavior for the two curves, suggesting that the problem of extrapolating the curves is equally complicated in the two cases. (auth)

7059 GENERATION OF MAGNETIC FIELDS IN ASTROPHYSICAL BODIES. I. THE DYNAMO EQUATIONS. Parker, E. N. (Univ. of Chicago). Astrophys. J.; 162: 665-73(Nov 1970).

A formal derivation of the dynamo equations describing the generation of large-scale magnetic fields by small-scale cyclonic turbulence (or convection) in a rotating fluid body is presented. The derivation is based on the simple approximation that the individual turbulent cells are small and short-lived. The dynamo equations show that large-scale magnetic fields are generated at a very high rate, in periods comparable to the time of nonuniform rotation. The dynamo equations describe the generation of the quasi-steady field of Earth and the migratory field of the Sun, in characteristic times of 10^3 and 10 years, respectively. (auth)

7060 RE-INTERPRETATION OF OSO-III SCINTILLATION COUNTER MEASUREMENTS OF HARD SOLAR X-RAY SPECTRA. Kane, S. R. (Univ. of California, Berkeley); Hudson, H. S. Solar Phys.; 14: 414-18(Oct 1970).

Laboratory tests show that pulse pile-up requires a significant correction to the response of scintillation counters to solar x-ray bursts with steep energy spectra. The interpretation of the OSO-III and other satellite data in view of these corrections indicates that steep solar x-ray spectra with varying emission measure produce an effect similar to that produced by relatively hard spectra with a constant emission measure. (auth)

7061 SMALL ANISOTROPY AND THE RIGIDITY SPECTRUM OF THE MARCH 30, 1969 SOLAR FLARE EVENT. Bukata, R. P.; Gronstal, P. T.; Palmeira, R. A. R. (Univ. of Texas, Dallas). Solar Phys.; 14: 419-26(Oct 1970).

A study of the March 30, 1969 solar flare event is presented utilizing data obtained from the world-wide network of neutron monitors. Although, to a good first approximation, the solar flare radiation displayed a high degree of isotropy at the orbit of the Earth, it is deduced that a small anisotropy from East of the Earth–Sun line was present at the time of maximum enhancement of the event. This small deduced anisotropy does not, however, preclude the use of a method, based on isotropic particle propagation, to calculate the rigidity spectral index of the flare-induced radiation. Use of such a method determines the differential rigidity spectral index to be 3.9 ± 0.1. (auth)

7062 SEARCH FOR SOLAR NEUTRONS NEAR SOLAR MAXIMUM. Cortellessa, Paolo; Di Benedetto, Paolo; Paizis, Constantinos (Univ., Milan). Solar Phys.; 14: 427-39(Oct 1970).

A plastic scintillation counter with anticoincidence screen was flown in two 4-hour balloon flights, at a floating altitude of 3.2 and 3.5 mb, during day- and night-time respectively. Comparison between the day- and night-time counting-rates gives an upper limit of $\approx 10^{-2}$ n/cm^2 sec above 45 MeV for the continuous emission flux. This upper limit is compared with those derived from other experiments in function of the neutron energy spectrum assumed, and also with the expected continuous emission deduced from solar proton fluxes reported in nonflare conditions. It is concluded that with

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present experimental techniques, nonflare solar neutron emission can be detected only if the proton fluxes observed represent less than 10^{-3} of the protons accelerated in the Sun. (auth)

7063 QUASI-STATIONARY CORONAL MAGNETIC FIELD AND ELECTRON DENSITY AS DETERMINED FROM A FARADAY ROTATION EXPERIMENT. Stelzried, C. T. (California Inst. of Tech., Pasadena); Levy, G. S.; Sato, T.; (and others). Solar Phys.; 14: 440-56(Oct 1970).

Pioneer VI was launched into a circumsolar orbit on December 16, 1965, and was occulted by the Sun in the latter half of November, 1968. During the occultation period, the 2292-MHz S-band telemetry carrier underwent Faraday rotation due to the interaction of this signal with the plasma and magnetic field in the solar corona. The NASA/JPL 210-ft diameter antenna of the Deep Space Network near Barstow, California, was used for the measurement. The antenna feed was modified for automatic polarization tracking for this experiment. The measurement results are interpreted with a theoretical model of the solar corona. This model consists of a modified Allen–Baumbach electron density and a coronal magnetic field calculated both from Mount Wilson magnetograph observations using a source surface model and field extrapolations from the Explorer 33 satellite magnetometer. The observations and the calculated rotation show general agreement with respect to magnitude, sense, and timing, suggesting the source–surface model and field extrapolations from 1 AU are a valid technique to obtain the magnetic field in the corona from 4 to 12 solar radii. Variations present can easily be ascribed to density enhancements known to be present in the corona. Longitudinal variations of the density in the corona cannot be obtained from coronagraph observations, and thus a purely radial variation was assumed. An improved fit to the Faraday rotation data is obtained with an equatorial electron density $N = 10^8 (6000/R^{10} + 0.002/R^2) \ldots cm^{-3}$ $(4 < R < 12) \ldots$ where R is in solar radii. (auth)

7064 STUDY OF THE COMPOSITION OF THE SOLAR CORONA AND SOLAR WIND. Nakada, M. P. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 14: 457-79(Oct 1970).

Effects of diffusion on the composition of the solar corona and solar wind were examined. Multi-component diffusion equations were solved simultaneously in attempts to account for the flux of He and heavier elements in the solar wind. Large enhancements of these elements at the base of the assumed isothermal corona appear to be required to give observed fluxes. Coronal conditions and solar wind fluxes that might account for the diffusive presence of Fe at high altitudes were studied. (auth)

7065 UNIQUE SOLUTIONS OF SOLAR WIND MODELS WITH THERMAL CONDUCTIVITY. Weber, E. J. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys.; 14: 480-8(Oct 1970).

The solutions of a radially symmetrical solar wind model with thermal conductivity are discussed in the neighborhood of the loci of the critical points, called the critical line, and at infinity. It is shown that for constant mass and total energy flux the conditions at infinity are related uniquely to the conditions at the critical line. Furthermore, the requirement that the solution is continuous and has the proper behavior at infinity will determine uniquely one specific point on the critical line through which the solution has to pass. (auth)

7066 TWO-DIMENSIONAL GUIDING-CENTER MODEL OF THE SOLAR WIND–MOON INTERACTION. Whang, Y. C. (Catholic Univ. of America, Washington, D. C.). Solar Phys.; 14: 489-502(Oct 1970).

A continued study of the two-dimensional guiding-center model of the solar-wind interaction with the Moon is presented. The characteristics theory and the computational method are discussed. The magnetic permeability of plasma is $(1 + \beta/2)^{-1}$ in the solar-wind flow upstream of the Moon, and it changes to 1 in the void region of the lunar wake. The gradual change of the magnetic permeability in the penumbral region from the interplanetary condition to the void condition is explained as the source of field perturbations in the lunar wake. Perturbations of the magnetic field propagate as magneto-acoustic waves in a frame of reference moving with the plasma flow. Computer solutions were obtained to show that (i) the two principal perturbations of the magnetic field in the lunar wake (the umbral increase and the penumbral decrease) are confined to a region bounded by a Mach cone tangent to the lunar body, and (ii) the penumbral increases occur outside the lunar Mach cone. Computer solutions are also used to identify the source of field perturbations and to simulate the solar wind–moon interaction under varying interplanetary conditions. (auth)

7067 SIMPLE IMAGE FORMING TECHNIQUE SUITABLE FOR MULTIFREQUENCY OBSERVATIONS OF SOLAR RADIO BURSTS. Swarup, G.; Kapahi, V. K. (Tata Inst. of Fundamental Research, Bombay). Solar Phys.; 14: 404-13(Oct 1970).

A simple image forming system using a multielement interferometer for obtaining rapid pictures of solar radio bursts is described. A dispersive transmission line is used to feed the elements in series through directional couplers. Truly instantaneous pictures of solar activity can be obtained by placing a number of narrow frequency filters at the end of the I. F. amplifier in the main receiver, located at one end of the array. The two-dimensional extension of this principle is examined in some detail. Multibeaming in the two arrays of a crossed grating interferometer can be combined with fast phase-scanning in one of the arrays to produce rapid pencil beam pictures. If log-periodic antennas are used, observations can even be made at widely different frequencies simultaneously. For illustration, some important parameters for simultaneous observations at 60, 90, and 120 MHz are estimated for an interferometer assumed to be located at a latitude of 30°N. The main advantage of the proposed system is that high-resolution rapid pictures of radio bursts can be obtained simultaneously at a number of frequencies with modest effort. (auth)

7068 PHOTOSPHERIC MAGNETIC FIELD ROTATION: RIGID AND DIFFERENTIAL. Wilcox, John M. (Univ. of California, Berkeley); Schatten, Kenneth H.; Tanenbaum, Andrew S.; Howard, Robert. Solar Phys.; 14: 255-62(Oct 1970).

An autocorrelation of the direction of the large-scale photospheric magnetic field observed during 1959–1967 yielded evidence that the field structure at some heliographic latitudes can display both differential rotation and rigid rotation properties. (auth)

7069 HALE'S ATTEMPTS TO DETERMINE THE SUN'S GENERAL MAGNETIC FIELD. Stenflo, Jan Olof (Astronomical Observatory, Lund, Sweden). Solar Phys.; 14: 263-73(Oct 1970).

Hale's attempts to determine the Sun's general magnetic field are reviewed. The field reported by Hale was an order of magnitude stronger than that presently measured with photoelectric techniques. The polarity was opposite to that expected from Babcock's theory of the solar cycle. Practically all the reduction work had been made by Van Maanen with a tipping-plate micrometer. To free the reductions from possible personal bias, a few hundred of the plates from the 1914 series were remeasured by the author with the digitized microphotometer at the Sacramento Peak Observatory. The line profiles were recorded on magnetic tape, and the computations of the Zeeman displacements were made using a CD 3600 at Uppsala. The same plates had been measured visually by Van Maanen. His results show a neat variation of field strength with heliographic latitude, with a maximum of about 11 g at latitudes + and −45°. The solar equator forms a sharp demarcation line between the opposite polarities in the two hemispheres. In contrast, the computer reductions do not reveal any significant field at any latitude. An approximate upper limit for the observed field strength is 5 g. There is no correlation between the new results and the old values by Van Maanen. (auth)

7070 PRODUCTION OF THE SOLAR MAGNETIC FINE-STRUCTURE BY CONVECTION. Weart, S. R. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 14: 274-9(Oct 1970).

Motion of the gas in supergranular convection will produce twisted flux tubes. A simple energy calculation shows that for a wide variety of assumptions a tube of field strength ~100 g will be given about one twist and will have a diameter ~1000 to 2000 km. This agrees with observations of magnetic fine-structure on the Sun. (auth)

7071 INTERPRETATION OF VELOCITY FILTERGRAMS. III. VELOCITIES INSIDE SOLAR GRANULES. Beckers, J. M. (Sacramento Peak Observatory, Sunspot, N. Mex.); Morrison, R. A. Solar Phys.; 14: 280-93(Oct 1970).

From simultaneous filtergrams taken in opposite wings of the λ6569.2 solar absorption line the velocity profile of an average solar granule is derived. The existence of the horizontal outflow in a granule is definitely established in addition to the vertical upflow at the granule center. The magnitude of this outflow is strongly dependent on the influence of instrumental and atmospheric smoothing and on the effective height in the solar atmosphere at which the velocity is measured. The maximum upflow (at the granule center) equals 0.4 km/sec, the maximum outflow (500 km from the granule center) equals 0.25 km/sec. (auth)

7072 SEMI-EMPIRICAL SOLAR LINE BLANKETING. I. STATISTICAL BASIS AND METHOD. Mutschlecner, J. P. (Indiana Univ., Bloomington); Keller, Charles F. Solar Phys.; 14: 294-309(Oct 1970).

Statistical data for line blanketing in the solar atmosphere were extracted from the Revised Rowland Table. The data are corrected for apparent observational incompleteness due to line crowding and blending and are placed in a convenient form for calculations. An attempt is made to interpret the data in terms of schematic representations of the energy levels and distribution of gf-values for the important absorbers. The analysis leads to predictions in good agreement with the forms of the statistical data and substantiates the assumption of observational incompleteness in the original data. The analysis suggests that the solar data may provide useful guidance in the blanketing of stellar atmospheres sufficiently close to solar type. A blanketing method is presented which makes use of a uniformly smeared-line (single picket) procedure and which assumes LTE and a weak-line curve of growth. The blanketing coefficient is obtained in a simple manner from the corrected statistical data and is both depth and wavelength dependent. An alternative method utilizing a four-picket scheme and average absorption coefficient profiles is suggested. Comparison of solar models computed by the two methods shows good agreement and gives support for the smeared-line procedure. Comparison of the solar model with a non-LTE blanketed model of Athay also shows reasonable agreement. (auth)

7073 HORIZONTAL COMPONENT OF SPICULE MOTION. Weart, Spencer R. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 14: 310-14 (Oct 1970).

In movies of Hα spectra taken with the slit tangential to the solar limb one can observe motion of spicules both parallel to the slit and along the line of sight. Strong evidence is found that, although most motion is along the axis of the spicule, some features move at right angles to their axes. Several cases were observed of features separating into two widely split components. A power spectrum of the changes of Doppler shifts with time shows the 1/frequency characteristics of random motion. (auth)

7074 PHYSICAL CONDITIONS IN THE PHOTOSPHERIC NETWORK: AN IMPROVED MODEL OF SOLAR FACULAE. Chapman, Gary A. (Aerospace Corp., Los Angeles). Solar Phys.; 14: 315-27(Oct 1970).

Semi-empirical models of solar faculae, cospatial with strong photospheric magnetic fields, have been constructed from continuum observations. The center-to-limb contrast of the various models was computed taking into account their geometrical shape. The adopted model whose horizontal size was taken to be 750 km, indicates that, in field regions, the temperature begins to rise outwards at $z \approx -125$ km (above $\tau_{5000} = 1$) and that the extrapolated temperature at $z \approx -400$ km is about 1500K above that of the undisturbed atmosphere; the electron density is higher by a factor of about 30. (auth)

7075 ACTIVE REGIONS. I. THE OCCURRENCE OF SOLAR FLARES AND THE DEVELOPMENT OF ACTIVE REGIONS. Zirin, H. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Solar Phys.; 14: 328-41(Oct 1970).

A summary of data on the occurrence of flares and the development of active regions, based on cinematographic data is given. It is shown that flare frequency is determined by the orientation of the magnetic axis relative to the direction of solar rotation and the morphology of the magnetic field as seen in Hα. In particular, flares are most numerous in simple round spots with reversed polarity nearby, although they may also be frequent in complex spots with polarity reversal. Important solar active regions are shown to evolve principally along two lines; typically they appear as bright regions with loops and grow rapidly to stable bipolar magnetic form. Important activity will occur as the result of later growth of following polarity ahead of the main spots, or some other source of reversal. However, some groups appear as reversed polarity regions and grow rapidly to a level of extreme activity. (auth)

7076 ACTIVE REGIONS. II. MOUNT WILSON 16997: A SMALL SPOT WITH BIG FLARES. Zirin, H. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 14: 342-53(Oct 1970).

The great activity associated with Mount Wilson 16997 is described, a single αp spot without plage that produced a number of large flares and developed into a substantial center. The activity was signaled by the emergence of f polarity and weak plage ahead of the spot on September 24, 1968 (although the region was already seen at the limb at the September 22, 1968 eclipse as an active center). A number of explosive flares with x rays on the 25th were climaxed by a large flare at 0036 UT September 26; the latter was associated with the splitting of the old spot and the emergence of a new one. The polarity axis rotated around to a normal configuration by the 29th. but a large flare occurred on that day, too. Several of the flares show interesting details such as the return of spray material to the surface at the boundary of the region. The behavior of this region shows that: (1) Large flares may come from small, round spots; (2) The magnetic field rotation due to the action of the Hale–Nicholson force is a possible source of flare energy; and (3) Appearance and disappearance of spots is clearly connected with flare activity. (auth)

7077 MEASUREMENTS OF LINE-OF-SIGHT VELOCITIES IN PROMINENCES. Liszka, Ludwik (Kiruna Geophysical Observatory, Sweden). Solar Phys.; 14: 354-65(Oct 1970).

Measurements of line-of-sight velocities of quiescent and sunspot prominences on the limb made during the years 1966 and 1968 at Swedish Astrophysical Station in Anacapri, Italy are discussed. Several statistical properties of the velocity field, in particular its connection with close McMath plages are investigated. Results are interpreted in terms of oscillatory motion in prominences. (auth)

7078 RESULTS OF NEW ABSOLUTE MEASUREMENTS OF THE SOLAR FLUX DENSITY AT 9500 MHz. Keiser, J. (Heinrich-Hertz-Institut, Berlin). Solar Phys.; 14: 366-71(Oct 1970).

In the wavelength range of about $\lambda = 3.2$ cm a discrepancy existed between the absolute calibrations made by the Nagoya University and by the Heinrich–Hertz-Institut (HHI). In this paper a new calibration carried out at the HHI is described, which results in a corrective multiplier of 1.087 for the values published in the "HHI Solar Data." Employing this factor the results of the Nagoya group and of the HHI are in good agreement. (auth)

7079 THERMAL RUNAWAY AS THE SOLAR FLARE TRIGGER MECHANISM. Kahler, S. W.; Kreplin, R. W. (Naval Research Lab., Washington, D. C.). Solar Phys.; 14: 372-83 (Oct 1970).

It is postulated that the solar flare "trigger" mechanism is a thermal runaway that occurs in the inner corona. This runaway is the result of a radiative power function that decreases with increasing temperature. Relationships of the onsets of Hα flares, hard x ray, soft x ray, and centimeter radio bursts are consistent with the model. Flares are shown to be common solar phenomena which occur preferentially in hot and dense active regions. (auth)

7080 SOME CENTER-LIMB STATISTICAL TRENDS OF IMPULSIVE SOLAR BURSTS AT 7 GHz. Matsuura, O. T.; Nave, M. F. F. (Mackenzie Univ., Sao Paulo, Brazil). Solar Phys.; 14: 384-8(Oct 1970).

The more impulsive 7-GHz bursts seem to prefer the solar limb regions, while the degree of polarization decreases with increasing impulsivity. (auth)

7081 HOMOLOGOUS MICROWAVE BURSTS AND ASSOCIATED SOLAR FLARES. Rao, U. V. Gopala (Astrophysical Observatory, Kodaikanal, India). Solar Phys.; 14: 389-93(Oct 1970).

Homologous characteristics of radio bursts at 3000 MHz and associated optical flares were studied. It was found that flares associated with homologous radio bursts are also homologous optically. (auth)

7082 POSITIONS AND MOTIONS OF SOLAR BURSTS AT DECAMETER WAVELENGTHS. Kundu, M. R. (Univ. of Maryland, College Park); Erickson, W. C.; Jackson, P. D.; Fainberg, J. Solar Phys.; 14: 394-403(Oct 1970).

The positions and motions of solar bursts in the range 20 to 60 MHz were measured by the means of a sweep-frequency grating interferometer with angular resolution of 5′ arc at 60 MHz decreasing to 15′ arc at 20 MHz. The positional characteristics of the decameter wavelength bursts are discussed in terms of the commonly accepted theories of the origin of radio bursts from plasma and synchrotron radiations. (auth)

7083 PROPOSED MECHANISM FOR COMET FLARES. Eviatar, Aharon; Joseph, Joachim H.; Dryer, Murray (Tel-Aviv Univ., Israel). Astrophys. Lett.; 7: 27-9(Nov 1970).

A mechanism is proposed to explain the observed phonomenon of brightness fluctuations in comets. Shock waves generated by solar flares impinge on the comet nucleus and dust cloud, dislodging Platt particles, which are assumed to exist in the cometary atmosphere. The high reflectivity and small mass of these particles enhance the reflected intensity of the comet by several optical magnitudes, without entailing a major change in the comet size. The theory is applied to the well-documented flares of P/Schwassmann–Wachmann I and the observed features are found to be understandable in the light of the model. (auth)

7084 THEORETICAL MODELS OF SUNSPOTS. Yun, Hong Sik (Indiana Univ., Bloomington). Astrophys. J.; 162: 975-86 (Dec 1970).

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It is shown that Deinzer's models of sunspots can be improved by introducing a new surface boundary condition. The new boundary condition is derived by taking into account the effect of the horizontal pressure difference at the photosphere. Thirty-two models of sunspots are constructed by using as parameters the effective temperature, total magnetic flux, and inclination of the field at the outer edge of the penumbra. Some observable quantities such as the Wilson depression, the surface field strength, the vertical field gradient on the axis, and the total spot area are determined for these models and are compared with the observations. (auth)

7085 BIRTH AND GROWTH OF SUNSPOT REGIONS. Weart, Spencer R. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 162: 987-92(Dec 1970).

Some 100 active regions were observed in Hα during their first few days. The first sign is almost always a bright spot with dark arches. The arches for different new regions are oriented differently with respect to lines of latitude, and there is no striking predominance of any particular tilt. This suggests that the magnetic-field direction below the surface of the Sun has a random component. Most new regions may be classified as having either "correct" tilt (NE in the northern hemisphere, SE in the southern) or "contrary" tilt. All regions which survive the first few days take up a correct tilt; however, regions correctly tilted at the start are more likely to survive and grow than contrary ones. This indicates that the effect which causes sunspot groups to be oriented with the preceding spots nearer the equator operates after the emergence of magnetic flux. It is also found that interactions between separate flux tubes are important, for when two systems of arches arise in proximity, they are more likely to grow into a large active region. (auth)

7086 FIVE-MINUTE OSCILLATIONS ON THE SOLAR SURFACE. Ulrich, Roger K. (Univ. of California, Los Angeles). Astrophys. J.; 162: 993-1002(Dec 1970).

The acoustic properties of the subphotospheric layers are examined. It is shown that standing acoustic waves may be trapped in a layer below the photosphere. These standing waves may exist only along discrete lines in the diagnostic diagram of horizontal wavenumber versus frequency. The positions of these lines are derived from a modal analysis of the solar envelope. The lines for the fundamental mode and the first-overtone mode pass through the centers of the two peaks observed by Frazier. An examination of the energy balance of the oscillations shows that they are overstable. When they are assigned an amplitude of 0.2 km sec^{-1}, they generate about $(5-7) \times 10^6$ ergs cm^{-2} sec^{-1}. This power output suggests that the dissipation of the 5-minute oscillations above the temperature minimum is responsible for heating the chromosphere and corona. (auth)

7087 A $^2\Pi \rightarrow X\ ^2\Sigma^+$ SYSTEMS OF ^{24}MgH, ^{25}MgH, AND ^{26}MgH. Balfour, W. J. (Univ. of Victoria, British Columbia). Astrophys. J.; 162: 1031-5(Dec 1970).

Laboratory studies of the emission spectrum of MgH confirmed the identification by Branch of the isotopes ^{25}Mg and ^{26}Mg in the Sun. High-resolution measurements on lines of the 0-0 and 0-1 bands of the A $^2\Pi \rightarrow X\ ^2\Sigma^+$ systems of ^{25}MgH and ^{26}MgH are reported. (auth)

7088 SHOCK-TUBE MEASUREMENTS OF ABSOLUTE gf-VALUES FOR Fe I. Wolnik, S. J.; Berthel, R. O.; Wares, G. W. (Air Force Cambridge Research Labs., Bedford, Mass.). Astrophys. J.; 162: 1037-47(Dec 1970).

Absolute gf-values for 118 Fe I lines in the visible region of the spectrum were measured by shock-tube emission spectroscopy. Special attention was given to choosing relatively faint lines in a region of reasonably well-defined solar photospheric continuum and to eliminating systematic errors. For the latter purpose, the gas kinetic temperature was measured accurately by an ultrasonic technique for every shock, and a special study was made in which the various experimental parameters were varied over extreme ranges and in which the validity of the assumptions of local thermodynamic equilibrium (LTE) and of optical thinness were verified. The results are in fairly good agreement with Corliss and Tech's free-burning-arc measurements for low-excitation lines but show large disagreements for lines having high-excitation potentials. The magnitude of the discrepancies is largely dependent upon upper excitation potential and to a lesser extent upon wavelength. The measurements for low-excitation and high-excitation lines agree to within a factor of about 2 with values obtained by other independent investigations, which include shock-tube, wall-stabilized-arc, atomic-beam, and beam-foil measurements. These results suggest that the solar photospheric abundance of iron may need to be revised upward in the light of the various recent measurements of gf-values for high-excitation lines, which are consistently smaller than reported free-burning-arc values by nearly 1 order of magnitude. These free-burning-arc f-values and the furnace-absorption f-values upon which they are based have repeatedly led to the paradox of solar photospheric iron abundance about an order of magnitude lower than coronal. According to a line-profile fitting analysis by Ross (1970), the Fe I gf-values correspond to an increased photospheric abundance by a factor of about 5. (auth)

7089 SPECTRAL CHARACTERISTICS OF IMPULSIVE SOLAR-FLARE X RAYS $\geq$ 10 keV. Kane, S. R.; Anderson, K. A. (Univ. of California, Berkeley). Astrophys. J.; 162: 1003-18 (Dec 1970).

Characteristics of the impulsive x-ray component are deduced from thirteen bursts of hard ($\gtrsim$10 keV) x-rays observed with the OGO-5 satellite during the period March 21-June 30, 1968. Most of these impulsive x-ray bursts were associated with impulsive microwave bursts and optical flares of importance $\lesssim$1. For ~40 keV x rays the e-folding rise time and decay time are found to be 2 to 5 and 3 to 10 sec, respectively. At maximum intensity the x-ray spectrum is consistent with the form $\sim E^{-\gamma}$ photons cm^{-2} sec^{-1} keV^{-1}, where $2.7 \lesssim \gamma \lesssim 4.5$ and $10 \lesssim E \lesssim 70$ keV. The peak x-ray flux above 10 keV observed at the Earth was 10^{-6} to 10^{-5} ergs cm^{-2} sec^{-1}. Under the assumption that electron-proton bremsstrahlung is the mechanism for x-ray production, the spectrum of the energetic electrons in the x-ray source region has been deduced and is found to be consistent with the form $\sim E^{-\delta}$ electrons cm^{-2} sec^{-1} keV^{-1}, where $1.5 \lesssim \delta \lesssim 3.3$ and $10 \lesssim E \lesssim 100$ keV. The short rise time, the power-law energy spectrum, and the time of occurrence relative to the optical flare indicate that the impulsive x-rays $\gtrsim$10 keV are a nonthermal flash-phase phenomenon. There is evidence that the injection of energetic electrons into the x-ray source region occurs more or less continuously throughout the impulsive x-ray burst. This injection, combined with the loss of energetic electrons through escape and collisions, probably determines the time-intensity profile of an impulsive x-ray burst. (auth)

Galaxies

7090 GRAVITATIONAL FIELD OF A PARTICLE FALLING IN A SCHWARZSCHILD GEOMETRY ANALYZED IN TENSOR HARMONICS. Zerilli, Frank J. Princeton, N. J.; Princeton Univ. (1969). 167p. University Microfilms Order No. 70-14,251.

Thesis.

Dyson has proposed that the typical event detected by Weber's gravitational wave detector is a pulse of gravitational radiation given off when a star falls into a "black hole" near the center of the Galaxy. The problem of a small particle falling in a Schwarzschild background (black hole) is considered and its spectrum in the high frequency limit is examined. In formulating the problem it is essential to pose the correct boundary condition: gravitational radiation not only escaping to infinity but also disappearing down the hole. The problem is examined in the approximation of linear perturbations from a Schwarzschild background geometry, utilizing the decomposition into the tensor spherical harmonics given by Regge and Wheeler (1957) and Mathews (1962). The falling particle contributes a delta function source term (geodesic motion in the background Schwarzschild geometry) which is also decomposed into tensor harmonics, each of which "drives" the corresponding perturbation harmonic. An analysis is made of the relation between the Regge-Wheeler harmonics and those of Mathews which makes is possible to use the Regge-Wheeler harmonics (which are given in terms of derivatives of scalar spherical harmonics) for calculations, while using Mathews' form of the harmonics (linear combinations of scalar harmonics and a basis for symmetric tensors with appropriate Clebsch-Gordan coefficients) to obtain properties of the harmonics such as orthogonality and normalization. The power spectrum radiated to infinity is given in the high-frequency approximation in terms of the traceless transverse tensor harmonics called "electric" and "magnetic" by Mathews. (Diss. Abstr. Int., B)

7091 OBSERVATIONS OF GALACTIC AND EXTRAGALACTIC SOURCES BETWEEN 50 AND 300 MICRONS. Low, F. J. (Univ. of Arizona, Tucson. Rice Univ., Houston); Aumann, H. H. Astrophys. J.; 162: L79-85(Nov 1970).

Far-infrared observations are reported of the galactic nucleus, of two discrete sources near the galactic nucleus, of two sources associated with H II regions, and of two extragalactic sources. All these objects have spectral distributions peaking between 50 and 300 μ, and their luminosities range from 1.6×10^5 to 2×10^{12} $L_\odot$. (auth)

7092 BACKGROUND RADIO EMISSION IN THE GALACTIC LONGITUDE INTERVAL l^{II} = 20.8 TO 32.8°. Ariskin, V. I. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 396-9(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 493-8(May-Jun 1970).

Observations, conducted with the 22-m telescope of the Lebedev Institute of Physics, of the continuous radio emission of the Galaxy in the longitude interval l^{II} = 20.8 to 32.8° have shown that the background radio emission consists not simply of a flat component, but is composed of two components: a flat one and an intermediate one. The intermediate component is nonthermal in nature; in the range from 21.1 cm to 3.5 m, its spectral index is $\alpha = 2.40 \pm 0.15$. It is suggested that the maximum of thermal background radio emission in the direction l^{II} = 25.3° is due to the radio emission of one of the large-scale regions of ionized hydrogen. (auth)

7093 EXISTENCE OF A GALACTIC RADIO CORONA. Abramyan, G. L.; Benediktov, E. A.; Getmantsev, G. G.; Zinichev, V. A. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 14: 391-5(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 487-92(May-Jun 1970).

The experimental data on the intensity distribution of short-wave and ultrashort-wave cosmic radio emission over the sky can be satisfactorily explained with the simplest quasi-homogeneous models only if, together with the flat radio-emitting disk in the Galaxy, there is also a comparatively voluminous "radio corona." (auth)

7094 CHARACTER OF THE MOTION IN BINARY GALAXY SYSTEMS. Karachentsev, I. D. (Kiev State Univ.). Sov. Astron. AJ (Engl. Transl.); 14: 407-12(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 509-15(May-Jun 1970).

Three types of motion for the components of double galaxies are discussed: (1) disrupting systems with positive total energy; (2) components rotating in circular orbits; (3) components moving radially with negative total energy (oscillating). Expressions are derived for the regression $\bar{y}(x)$ in the radial-velocity difference of the components on their projected separation. The case of disrupting systems agrees best with the observational data. (auth)

7095 NONLINEAR STELLAR DENSITY WAVES AND THE SPIRAL STRUCTURE OF GALAXIES. Ptitsyna, N. G. (Astrophysical Inst., Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 400-2(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 499-502(May-Jun 1970).

Density waves of finite amplitude, not distorted by differential rotation and with the wavefront taking the shape of a logarithmic spiral or a straight line as circumstances dictate, may possibly exist in a self-gravitating single-component cylinder. It is shown that waves of small amplitude with the wavefront shaped as a logarithmic spiral or bar are capable of existing in the model discussed. (auth)

7096 EMPIRICAL PROPERTIES OF THE MASS DISCREPANCY IN GROUPS AND CLUSTERS OF GALAXIES. Rood, Herbert J.; Rothman, Victor C. A.; Turnrose, Barry E. (Wesleyan Univ., Middletown, Conn.). Astrophys. J.; 162: 411-23(Nov 1970).

Data compiled by de Vaucouleurs are used to derive dynamical parameters of nearby groups and clusters of galaxies. It is found that the mass ratio M_{VT}/M (ratio of virial-theorem mass to that derived by summing the masses of individual galaxies) is significantly correlated with both radius and velocity dispersion. Radius versus velocity dispersion gives only a marginal correlation. Analysis of supplementary data by Karachentsev corroborates these results. The ratio of the largest to smallest line-of-sight velocity of galaxies assigned to a group is nearly independent of their difference in apparent magnitudes. This and other tests suggest that contamination of groups by nonmembers is insignificant. If the groups are unstable, then the velocity–radius diagram suggests that the groups commenced hyperbolic expansion at a variety of epochs. If the groups are stabilized by hidden mass, then the empirical results imply that the fraction of hidden material increases with increasing radius (decreasing density) and increasing velocity dispersion. (auth)

7097 BALMER EMISSION LINES IN SEYFERT GALAXIES. Ptak, Roger (Bowling Green State Univ., Ohio). Astrophys. J.; 162: 425-30(Nov 1970).

If faster than thermal particles are present in the emitting region of the nucleus of a Seyfert galaxy, ion–atom collisions will contribute to the emission. What effect this should have on the emission spectrum, in particular on the Balmer decrement, was investigated. The emitting region was taken to be a half-ionized hydrogen gas with an electron density of 10^4 cm^{-3} and a temperature of 10^4K. Protons with an initial energy of 25 keV slow to thermal speeds in this gas. The density of these faster particles was chosen such that they maintain the ionization balance of the gas. Volume emission rates were calculated for the first three Balmer lines, and it was found that the emission was substantially changed by the collision processes. The effect was to make the calculated Balmer decrement steeper than that for the pure-recombination case. (auth)

7098 THE ISOTROPY OF THE DIFFUSE COSMIC X RAYS DETERMINED BY OSO-III. Schwartz, Daniel A. (Univ. of California, San Diego, La Jolla). Astrophys. J.; 162: 439-44(Nov 1970).

An x-ray telescope aboard the OSO-III satellite has scanned almost the entire sky during a 1-year period and has searched for anisotropies in the diffuse component. After excluding known galactic sources, the extragalactic cosmic x-rays between 7.7 and 38 keV have no component of peak-to-peak amplitude greater than 2% that varies smoothly over the entire sky. This limit to any 24-hour variation restricts the velocity of the Earth to less than 800 km sec^{-1} in any direction relative to a rest frame in which the x-rays would appear isotropic. For about one-quarter of the sky, the upper-limit confidence of 95% to an inhomogeneity within the half-response aperture of 11.5° radius equals 4%. At 10 keV there exists a 10% increase in counting rate associated with the galactic plane of equivalent line-source strength 0.012 ± 0.004 photons (cm^2 sec keV rad)$^{-1}$. The upper limit to x-rays associated with a galactic halo equals 3%. (auth)

7099 SPECTRUM OF DIFFUSE COSMIC X RAYS: 7.7 TO 113 keV. Schwartz, Daniel A.; Hudson, Hugh S.; Peterson, Laurence E. (Univ. of California, San Diego, La Jolla). Astrophys. J.; 162: 431-7(Nov 1970).

An x-ray telescope aboard the OSO-III satellite provided data from which was derived the intensity of diffuse cosmic x-rays in five energy bands between 7.7 and 113 keV. A single power law cannot represent the data in this energy range. The one year of satellite operation allowed a determination of systematic effects, so that the four lowest energy points have an accuracy of about 3%. They fit a power-law spectrum of index 1.7 ± 0.1 which "breaks" at 42 ± 4 keV to become 3.0 ± 0.3. The normalization constant gives an intensity of 15.2 photons (cm^2 sec sterad keV)$^{-1}$ at 1 keV. A more complicated spectral shape suggested by Brecher and Morrison fits the present data very well and provides a better extrapolation to data at $\frac{1}{4}$ keV and a few MeV than does the power law. (auth)

7100 ROTATION AND ANGULAR MOMENTUM OF GALAXIES. Hunter, C. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 162: 445-52(Nov 1970).

Current explanations attribute the rotation of galaxies either to primordial turbulence or else to tidal interactions between protogalaxies during their formation. The latter effect gives rise to angular momentum in the form of straining motion and asymmetrical shape rather than purely circular motion. Simple models of protogalaxies considered here show a strong tendency to contract to high-density asymmetrical states, and a variety of steady states of this kind can be achieved with angular momentum in both straining and rotational forms. (auth)

7101 EQUILIBRIA OF A GALAXY WHICH IS A SUPERPOSITION OF SUBSYSTEMS. Vandervoort, Peter O. (Univ. of Chicago. Sterrawacht, Leiden). Astrophys. J.; 162: 453-62 (Nov 1970).

A family of equilibrium configurations of a highly flattened, rapidly rotating galaxy which is a superposition of subsystems is described. A model of the solar neighborhood is constructed in terms of these configurations. The model represents the local structure of the Galaxy to within the accuracy to which the structure is known. However, according to the model, the local value of the surface density is 86 $M_\odot$ pc^{-2}; in contrast, recent models derived from the law of galactic rotation have surface densities of the order of 114 $M_\odot$ pc^{-2} in the solar neighborhood. This discrepancy could be accounted for in terms of a population of stars in the galactic halo; however, it is also possible that the discrepancy results entirely from errors in the basic data of galactic structure. The effect of the multiplicity of stellar populations on the stability of a galaxy with respect to axisymmetric oscillations is considered; it is found that the peculiar motions of the stars suffice to stabilize the Galaxy in the solar neighborhood even if the local value of the surface density is as large as 114 $M_\odot$ pc^{-2}. (auth)

7102 FORMATION OF INTERSTELLAR MOLECULAR HYDROGEN BY PHYSICAL ADSORPTION ON GRAINS. Augason, Gordon C. (Ames Research Center, Moffett Field, Calif.). Astrophys. J.; 162: 463-73(Nov 1970).

XUM

The formation of molecular hydrogen on interstellar grains by means of physical adsorption will proceed efficiently if the adsorptive potential is high enough and the grain temperature is low enough. The physical-adsorption process is examined. It is shown that electrostatic forces produce high adsorptive potentials in the case of silicate and graphite materials and that dispersive forces dominate on ices. The effect of heterogeneity of adsorption sites is examined. Available laboratory data are analyzed to determine the adsorptive potential of H atoms on silicates, graphite, and solid H_2 and H_2O. If the structure and composition of grains in space are similar to the materials considered in this study and if current estimates of grain temperatures are correct, then interstellar molecular hydrogen should be formed by physical adsorption on grains. The formation of H_2 in the Ophiuchus and Taurus clouds is examined to see if different adsorptive potentials exist on the grains in these two clouds. The conclusion is reached, based on the adsorptive potential for H on solid H_2 presented in this study, that if the formation of molecular hydrogen is occurring in these clouds it is apparently proceeding at the same rate in each cloud and that hydrogen mantles have not formed on the grains in either cloud. (auth)

7103 RANDOM FORCE-FREE MAGNETIC FIELDS. Lerche, I. (Univ. of Chicago). Astrophys. J.; 162: 675-81(Nov 1970).

The behavior of force-free magnetic fields is discussed from the point of view of random-function theory. It is demonstrated that under particular classes of random-function Ansätze, an ensemble-averaged magnetic field exists whose scale length is much larger than the correlation length of the random turbulence. It is suggested that research along these lines may yield a more complete understanding of the nature of the large-scale magnetic field of the Galaxy. (auth)

7104 GALACTIC COMPONENT OF THE DIFFUSE X-RAY BACKGROUND. Webster, A. S. (Cambridge Univ., Eng.). Nature (London); 228: 544(7 Nov 1970).

It is stated that Wickramasinghe's model for the galactic component of the diffuse x-ray background, which involves scattering of the isotopic component by dust grains, involves a fundamental error that completely invalidated it. Particles along a line of sight may scatter isotropic background radiation into the line of sight, but by the same process they will also scatter out of the line of sight the background radiation originally travelling in this direction. If there is no absorption (that is, the albedo is unity) the two scattering effects are equal and the situation satisifies the first and second laws of thermodynamics and ensures that the galactic disk is indistinguishable from the rest of the background. If the albedo is less than unity the disk should show up in absorption, in contradiction with observations. Under no conditions can the model increase the flux from the disk relative to that of the isotropic background. (UK)

7105 GALACTIC SCATTERING AND DISCRETE SOURCES AS POSSIBLE ORIGINS OF THE DIFFUSE GALACTIC X-RAY BACKGROUND. Mack, J. E. (Univ. of Houston, Tex. Manned Spacecraft Center, Houston, Tex.). Nature (London); 228: 543 (7 Nov 1970).

Reference is made to Wickramasinghe (Nature 227: 265(1970)) who offered an explanation of the excess diffuse x-ray background intensity observed at low galactic latitudes based on small-angle scattering of the universal isotropic flux of x rays by interstellar grains. The present author seriously questions this hypothesis, from geometry considerations alone, thus avoiding the uncertainties in the present state of knowledge of these grains. If photons are deflected towards the Sun by interstellar grains an equal number must be deflected away, and another explanation must be sought for the observed excess of diffuse x rays near the galactic plane. Arguments have been put forward against an origin in discrete sources on the grounds that the excess is too smoothly distributed in space, but a model is discussed, possibly realistic on a galactic scale, which assumes uniform source distribution, and it is concluded that the discrete source hypothesis cannot be lightly dismissed. (UK)

7106 GALACTIC SOFT X RAYS AND THE ALIGNMENT OF INTERSTELLAR GRAINS. Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London); 228: 540-2(7 Nov 1970).

It is suggested that an excess flux of soft x rays in the galactic disk could result in the alignment of interstellar grains, which is required to explain the observations of interstellar polarization. (auth) (UK)

7107 OBSERVATIONS OF THE NEUTRAL HYDROGEN CONTENT OF DISTANT GALAXIES. McCutcheon, W. H.; Davies, R. D. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 150: 337-57(1970).

The neutral hydrogen content of nine Sb and Sc galaxies, with redshifts in the range 1545 to 2620 km s^{-1} were obtained. Eight of these galaxies have high intrinsic luminosities ($L > 19 \times 10^9 L_\odot$). The observations were made at Jodrell Bank with the Mark I in two pencil-beam studies using bandwidths of 34 and 18 kHz. All the galaxies were smaller than the beamwidth of the Mark I telescope. Some of the galaxies were observed with the Mark I–Mark II interferometer using a 100-kHz bandwidth. Four of the galaxies, NGC 772, 2776, 4303, and 5658, produced intense enough signals when observed with the Mark I telescope to give an integrated spectrum from which the neutral hydrogen content, the total mass, and the systemic velocity could be estimated. NGC 2776 was the only galaxy in which neutral hydrogen was detected with the interferometer. A continuum source with a diameter 0.17 of the optical diameter was found at the center of NGC 972. The measured systemic velocity of NGC 2776 is 2620 ± 10 km s^{-1}, the highest velocity detected so far at 21 cm. Optical and 21-cm velocity measurements of external galaxies are now available for a total velocity range of 2967 km s^{-1} and indicate that the cosmological redshift is the same to within 1% over a wavelength range of 5×10^5: 1. (auth) (UK)

7108 REPLY TO MACK AND WEBSTER. Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London); 228: 544 (7 Nov 1970).

A reply is made to Mack (Nature 228: 543(1970)) and Webster (loc. cit. 228: 544(1970)). It is stated that a diffuse galactic x-ray component, similar to that observed, could arise both by scattering of the isotropic background by dust and by discrete sources. Mack neglects scattering by dust, but it is likely that this effect is important for distances exceeding a few kpc. The author's analysis (Nature 227: 265(1970)) is valid for this case subject to two provisos: (a) discrete x-ray sources are distributed more or less uniformly, with respect to mean volume emissivity; throughout the hydrogen–dust layer of the galaxy; and (b) the intensity is defined as the ratio of the mean x-ray emissivity (due to sources) per unit volume to the x-ray extinction per unit distance, and this quantity is assumed comparable with the intensity of isotropic background. A scattering model of the type considered could produce a fairly smooth galactic x-ray background, with the observed concentration towards the galactic plane, without requiring an excessive concentration of weak unresolved sources very near the galactic plane. (UK)

7109 INTERSTELLAR H_3^+. Stecher, T. P. (Goddard Space Flight Center, Greenbelt, Md.); Williams, D. A. Astrophys. Lett.; 7: 59-60(Nov 1970).

The processes of production and destruction of H_3^+ may contribute to the extinction of some young hot stars for wavelengths less than 2500 Å. (auth)

7110 RADIO EMISSION FROM MARKARIAN GALAXIES. Longair, M. S. (Cambridge Univ., Eng.); Malumian, V. H.; Sargent, W. L. W. Astrophys. Lett.; 7: 23-5(Nov 1970).

Upper limits to the radio emission from 31 Markarian galaxies with apparent photographic magnitudes in the range 13 to 17.5 are reported. The astrophysical significance of the weakness of the radio emission from these objects is discussed and the desirability of further studies at radio and infrared wavelengths is stressed. (auth)

7111 CORRELATION OF OPTICAL ABNORMALITIES AND SMALL RADIO SOURCES IN GALAXY NUCLEI. Tifft, William G. (Univ. of Arizona, Tucson). Astrophys. Lett.; 7: 7-9(Nov 1970).

Radio emission from small sources in galaxy nuclei is shown to be correlated with the optical photometric properties. Within the limitations of the small sample available, the following observations are made: (1) no galaxy with a photometrically normal nuclear region contains a small radio source, although it may contain a large source; (2) when a small radio source is present the galaxy nuclei are abnormally red or blue. The opposite is not true, however, since (3) not all photometrically blue or red nuclei contain small radio sources. Finally, (4) the sources in red nuclei are apparently smaller than in blue nuclei and are the ones showing abnormal radio spectra. A close similarity between the abnormal nuclei and QSS phenomena is noted, and it is proposed that the phenomena are either small scale QSS phenomena, or pre and/or post QSS stages. (auth)

7112 LANES IN Sc GALAXIES INTERPRETED AS SHOCK WAVES IN SPIRAL ARMS. Pikelner, S. B. (Sternberg Astronomical Inst., Moscow). Astrophys. Lett.; 7: 11-14(Nov 1970).

Interstellar gas when it crosses spiral arms is decelerated by the gradient of the total pressure or by shock waves. A great deal of the gas in arms is in a dense phase. If the difference in average densities of the gas is less than about 10, the same clouds will be

conserved, being between arms, but their density and the density of the rarefied phase is correspondingly lower. The rarefied gas forms a front, but clouds penetrate into the arm without great deceleration. The degree of compression in the shock is determined by the equality of the internal pressure and the pressure of the stream. The internal pressure consists of gaseous, magnetic, and turbulent pressures. The density of the dark lanes is 10 cm^{-3} or more. Such high compression is possible if the magnetic field in Sc galaxies is ≤0.9 N microgauss and random velocities are ≤2 km sec^{-1}; i.e., magnetic field and velocities there are considerably less than in our Galaxy. Behind the front, almost all the gas is transformed into the dense phase, then its motion accelerates, its density decreases, and part of the gas is transformed into a rarefied phase. This process is irreversible; therefore the kinetic energy of circular motion decreases, and the gas approaches to the center of the galaxy. Large clouds cross part of the arm, the stream of the gas along the arm runs across the clouds, shock waves are formed and flow down with the stream. It is possible that this may explain the dark "feathers." In SBc galaxies, shocks and displacement to the center should be considerably stronger than in Sc galaxies. This is not supported by the observations. A picture of rotation which is similar to the rigid body one seems more probable. (auth)

7113 DIFFUSION OF LYMAN ALPHA THROUGH THE GALAXY. Adams, Thomas Frederick. Madison, Wis.; Univ. of Wisconsin (1970). 73p. University Microfilms Order No. 70-8255.

Thesis.

A method is presented for studying the transfer of resonance-line radiation in media of extremely large optical thickness. To start each solution to the transfer problem, an initial guess was made at the frequency- and space-dependence of the source function. An iteration procedure was used to solve the equation of transfer. The equation of radiative equilibrium was used to determine the distribution of sources necessary to support this radiation field. Photon destruction mechanisms can be included in the transfer problem through the equation of radiative equilibrium. Different initial guesses were tried until one was found that led to a radiation field whose distribution of sources approximates the desired distribution. This method was applied to the diffusion of hydrogen Lyman alpha (Lα) in a plane-parallel slab with a half thickness of $\tau_0 = 2 \times 10^5$ in line center optical depth units. This represented the galactic plane near the Sun if inhomogeneities in the neutral hydrogen medium (e.g., clouds) were ignored and a Doppler width corresponding to a turbulent velocity of 13 km/sec was assumed. The sources of Lα were assumed to be distributed continuously with a concentration toward the galactic plane. Under these assumptions 90% of the Lα photons created are destroyed by absorption on grains. The remaining photons escape the Galaxy some 15 to 35 Doppler widths (0.8 to 1.8 Å) from the center of Lα. Quantitative estimates of the mean intensity in the medium and the emergent flux are given, based on a simple model for the Lα sources. (Diss. Abstr. Int., B)

7114 SEARCH FOR HIGH-ENERGY GAMMA RAYS FROM THE CYGNUS REGION. Valdez, Jesusa Villanos. Minneapolis; Univ. of Minnesota (1969). 113p. University Microfilms Order No. 70-15,829.

Thesis.

A nuclear emulsion-spark chamber detector was flown on July 7, 1967 to search for gamma rays (E > 100 MeV) from the Cygnus region. This part of the sky includes the strongest radio galaxy Cygnus A, the x-ray source Cygnus XR-I, and that portion of the galactic plane between longitude $60° < l^{II} < 90°$. Although evidence has been reported for a point source in the Cygnus region at a declination of 35° and right ascension of 304°, none with fluxes greater than 3×10^{-5} gamma rays/cm^2 sec were observed in this experiment. New upper limits of 1×10^{-5} gamma rays/cm^2 sec were set at the 95% confidence level for Cygnus A and Cygnus XR-I. The emission from the galactic equator included in this region of scan could be attributed to a line intensity of $[3 \pm 1.5] \times 10^{-4}$/$cm^2$ sec rad from a band in the latitude interval $-1.5° \leq b^{II} \leq 4.5°$. This intensity is consistent with that observed by the OSO III detector in the Cygnus direction. The atmospheric background of gamma rays was studied in detail and its differential energy spectrum was found to fit a power law in the energy range 100 to 2500 MeV. The most likely mechanisms of gamma-ray production in Cygnus A are described, and it is shown that inverse Compton scattering will be an inefficient process for creating gamma rays of energies >100 MeV. The decay of neutral pions arising from nuclear interactions is the most likely source of gamma rays, if any are observed in the future. Possible explanations for the high galactic line emission are also discussed. (Diss. Abstr., Int., B)

7115 SPECTROPHOTOMETRY OF EIGHT SEYFERT GALAXIES. Anderson, Kurt S. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 162: 743-59(Dec 1970).

The optical spectra of the nuclear regions of eight Seyfert galaxies, NGC 1068, NGC 1275, NGC 3227, NGC 3516, NGC 4051, NGC 4151, NGC 5548, and NGC 7469, were examined. The observational material consisted of photographic spectra and photoelectric-scanner measurements covering the wavelength range λ 3400 to 8400. Line intensities, line profiles, and continuous energy distributions were derived. The line profiles were interpreted in terms of mass motions and electron scattering. Line-intensity data indicated temperatures of approximately 10^4 °K, and the electron densities ranged from 10^2 to 10^9 cm^{-3} throughout the emitting regions. The problems of internal reddening were considered. The anomalous Balmer decrements observed may be partly a consequence of self-absorption effects. The continuous energy distributions were found to be quite different from those of normal nuclei. The stellar contribution to the observed continuum was clearly abnormal in at least one instance. A recombination continuum was found to be insufficient in accounting for the purely nuclear continuum, and the presence of a significant nonthermal continuum component was indicated. The optical polarization observed for some objects may be a manifestation of this nonthermal component, or it may be due to the material producing the observed reddening. (auth)

7116 ELECTRON SCATTERING IN SEYFERT GALAXIES. Mathis, John S. (Univ. of Wisconsin, Madison). Astrophys. J.; 162: 761-70(Dec 1970).

Physical conditions in the nuclei of the Seyfert galaxies NGC 3227, NGC 4151, NGC 5548, and NGC 7469 are discussed by fitting theoretical profiles of electron-scattered lines to the observed hydrogen-line profiles of Anderson. The principal parameters are (1) the width of the wings and (2) w, the strength of the unscattered core relative to the total strength. With these parameters the optical depth, the temperature, the density, and the size of the electron-scattering regions were estimated. The theoretical values of w were obtained by assuming that the Balmer lines are scattered only by electrons. The observed value of w is an upper limit, since the material which emits forbidden lines also contributes unscattered hydrogen-line radiation to the core. Corrections to the observed values of w were made by conservatively estimating, for the hydrogen radiation from the forbidden-line region, either one of two assumed temperatures, 2×10^4 ° or 1.3×10^4 °K. The derived values of the densities in the electron-scattering region were ~10^7 to 10^{10} electrons cm^{-3}. The temperatures were usually in the range (2 to 4) $\times 10^4$ °K, although with the forbidden-line region at 1.3×10^4 °K they were ~1×10^4 °K. If the forbidden-line region is as cool as 1×10^4 °K, then the entire observed core can be contributed by the forbidden-line region, and the temperature of the electron-scattering region would be impossibly low. If the electron-scattering region is as cool as 10^4 °K, the continuous absorption of the gas destroys Balmer photons. The derived masses for the electron-scattering region are always small ($<10^3$ $M_\odot$). The thicknesses are less than 0.1 pc. (auth)

7117 COOLING MECHANISMS IN THE INTERSTELLAR GAS. Penston, M. V. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 162: 771-81(Dec 1970).

Fine-structure transitions of neutral carbon and the 5201-Å line of neutral nitrogen are discussed as sources of cooling in the interstellar gas. The role of different coolants is studied as a function of density. Several observations are suggested from these results. First, emission of λλ6300 and 5201 of neutral oxygen and nitrogen from the intercloud medium may be detectable from above the atmosphere away from the masking effect of the same lines in the upper atmosphere; second, observation of emission of ionized carbon at 156 μ in the infrared would determine the heating rate of the interstellar gas. Finally, observation of the interstellar absorption lines at 1334 and 1336 Å from the same species in the ultraviolet would give the same information. (auth)

7118 EFFECTS OF STELLAR COLLISIONS IN DENSE STELLAR SYSTEMS. Sanders, Robert H. (Princeton Univ., N. J.). Astrophys. J.; 162: 791-809(Dec 1970).

Effects of stellar collisions, such as mass and energy losses and the question of whether or not two colliding stars coalesce to form a more massive star, were investigated by numerical calculations which utilize a simple physical model. The results of these calculations were then applied by use of Monte-Carlo techniques in a computer simulation of dense stellar systems in order to indicate approximately how the distribution of stellar masses changes as the systems evolve. In the simulation of a system with a total mass of 10^5 $M_\odot$ it was found that coalescence

XUM

does not lead to the buildup of massive stars, whereas for a 10^7 $M_\odot$ system there is a pronounced tendency to build up a few very massive stars. The supernova rate from coalesced stars in 10^8 $M_\odot$ and 10^7 $M_\odot$ systems is incapable of explaining the luminosities of Seyfert galaxies or QSOs. (auth)

Cosmology

7119 FUNDAMENTAL EQUATIONS FOR COSMOLOGICAL MODELS WHICH INCLUDE MATTER AND RADIATION. Sapar, A. (Inst. of Physics and Astronomy, Tallin). Sov. Astron. AJ (Engl. Transl.); 14: 403-6(Nov-Dec 1970).

Translated from Astron. Zh.; 47: 503-8(May-Jun 1970).

A short resume of the author's previous work on exact solutions to the equations describing the evolution of the Universe, and on the precise observed relations for a homogeneous, isotropic Universe filled with matter and radiation is presented. A brief, partly critical review of work by others on the same topics is given. (auth)

7120 EFFECT OF QUANTUM CONDITIONS IN A FRIEDMANN COSMOLOGY. Hoyle, F.; Narlikar, J. V. (Cambridge Univ., Eng.). Nature (London); 228: 544-5(7 Nov 1970).

The observed isotropy of the microwave background and its primordial interpretation have led to many investigations of the nature of particle horizons in cosmological models near the initial singularity. The standard Friedmann radiation Universe is considered in this connection. Near the singularity t = 0, very limited causal communication is possible between different parts of the Universe, in such a model, and the observed isotropy cannot be understood except as arising from artificially imposed initial conditions. It is pointed out that, near the singularity, quantum effects are important and may permit unlimited communication near t = 0. Feynman's path integral approach (Rev. Mod. Phys. 20: 367(1948)) to a quantum theory of gravitation is adopted, since it best illustrates the difference between the classical and quantum theories, and the basic concepts in relation to gravitation are discussed. The question is also discussed concerning whether the arguments would be seriously changed by an electromagnetic field, such as the microwave background, assumed primaeval. A transverse field would not directly affect the argument if uncoupled from matter. Near t = 0, the background would have a very high temperature and a profusion of particle pairs would be created; but such particles would not be co-moving with respect to the coordinate system, and in so far as particles move at speeds close to that of light they behave essentially as quanta, and the situation is not changed. It is concluded that there appears to be a strong case that quantum effects are important in establishing communication near the singularity of a Friedmann cosmology. (UK)

7121 PRIMEVAL ADIABATIC PERTURBATION IN AN EXPANDING UNIVERSE. Peebles, P. J. E. (Princeton Univ., N. J.); Yu, J. T. Astrophys. J.; 162: 815-36(Dec 1970).

The general qualitative behavior of linear, first-order density perturbations in a Friedmann–Lemaître cosmological model with radiation and matter has been known for some time in the various limiting situations. An exact quantitative calculation which traces the entire history of the density fluctuations is lacking because the usual approximations of a very short photon mean free path before plasma recombination, and a very long mean free path after, are inadequate. Results of the direct integration of the collision equation of the photon distribution function are given for treating in detail the complicated regime of plasma recombination. Starting from an assumed initial power spectrum well before recombination, a final spectrum of density perturbations after recombination is obtained. The calculations are carried out for several general-relativity models and one scalar-tensor model. One can identify two characteristic masses in the final power spectrum: one is the mass within the Hubble radius ct at recombination, and the other results from the linear dissipation of the perturbations prior to recombination. Conceivably the first of these numbers is associated with the great rich clusters of galaxies, the second with the large galaxies. The expected residual irregularity in the radiation from the primeval fireball is also computed. If it is assumed that (1) the rich clusters formed from an initially adiabatic perturbation and (2) the fireball radiation has not been seriously perturbed after the epoch of recombination of the primeval plasma, then with an angular resolution of 1 minute of arc the rms fluctuation in antenna temperature should be at least $\delta T/T = 0.00015$. (auth)

Planetary Phenomena

7122 PRODUCTION AND ESCAPE OF HYDROGEN ON MARS. Hunten, D. M.; McElroy, M. B. (Kitt Peak National Observatory, Tucson, Ariz.). J. Geophys. Res.; 75: 5989-6001 (1 Nov 1970).

Spectroscopic observations of water vapor on Mars are shown to be consistent with the temperature profiles of Gierasch and Goody. The corresponding column photodissociation rates are about 10^{10} cm^{-2} sec^{-1} near the subsolar point, and perhaps 10^9 cm^{-2} sec^{-1} for a planetary average. The subsequent chemistry and transport of the fragments is discussed. Among the forms of odd hydrogen, HO_2 may dominate over H and OH near the surface, but H is most important at great heights. The mixing ratio of H_2 is between 10^{-6} and 10^{-4}, depending on the assumptions made. H_2 is converted into odd hydrogen by $O(^1D)$ and CO_2^+, and very little penetrates to the exosphere. The escape flux of H is estimated to be around 10^8 cm^{-2} sec^{-1}, and the concentration at 200 km around 10^4 cm^{-3}. This flux, continued for 2×10^9 years, would remove 2.5 meters of solid ice and leave behind a corresponding large amount of free oxygen. (auth)

7123 EXCITATION PROCESSES FOR MARTIAN DAYGLOW. McConnell, John C.; McElroy, Michael B. (Kitt Peak National Observatory, Tucson, Ariz.). J. Geophys. Res.; 75: 7290-3 (1 Dec 1970).

The excitation processes for the Cameron bands of CO observed in the Martian limb dayglow are discussed. The atomic oxygen transition at 2972 A is briefly discussed. The Cameron bands correspond to the optically forbidden transition $a\ ^3\Pi \rightarrow X\ ^1\Sigma^+$, and their intensity measured by Mariner exceeds 500 kR at the planetary limb. The emission is not produced in a primary excitation process involving CO. The parent molecule is a minor constituent, and its most prominent transition, $A\ ^1\Pi \rightarrow X\ ^1\Sigma^+$, is a weak component of the airglow. In addition to electron dissociation of CO_2, the likely excitation mechanisms are photodissociation of CO_2 and dissociative recombination of CO_2^+. Dissociative recombination of O_2^+ is a minor source of $O(^1S)$. Calculated rates for electron excitation of λ2972 are lower than observed values by about a factor of 10. Intensities calculated for the Cameron bands and for λ2972 are shown by assuming excitation by photodissociation of CO_2. The main continuum associated with $O(^1S)$ production is first apparent at 1200 A and reaches a maximum at about 1120 A. (J.C.W.)

7124 HYDROMAGNETICS OF ROTATING FLUIDS. Eltayeb, Ibrahim A.; Roberts, Paul H. (Univ. of Newcastle upon Tyne, Eng.). Astrophys. J.; 162: 699-701(Nov 1970).

There are two essentially different states of motion which can occur when a conducting fluid is driven by given forces (e.g., buoyancy): either (a) a state in which the magnetic field is zero and the amplitude of motion is such that viscous friction disposes of all energy available or (b) one in which a magnetic field is present, and in which viscous and ohmic dissipation jointly balance the energy supplied. Apparently, nature often "chooses" solution (b), and, as a result of the study of a simple model, it is suggested here that Coriolis forces may be responsible for this. (auth)

7125 LUNAR ANORTHOSITES: RARE-EARTH AND OTHER ELEMENTAL ABUNDANCES. Wakita, Hiroshi; Schmitt, Roman A. (Oregon State Univ., Corvallis). Science; 170: 969-74(27 Nov 1970).

Elemental abundances of major (Ti, Al, Fe, and Ca), minor (Na, Mn, and Cr), and trace elements [14 rare-earth elements (REE), Y, In, Cd, Rb, Cs, Ba, Co, and Sc] in lunar anorthosites separated from Apollo 11 sample 10085 coarse fines were determined by means of instrumental and radiochemical neutron activation analysis. The REE distribution pattern of lunar anorthosites, relative to ordinary chondrites, has a positive Eu anomaly. On the assumption that (i) the lunar composition is similar to that of ordinary chondritic meteorites low in total Fe (~13%); (ii) lunar anorthosites are derived from highland cratering events and are representative of the highlands; and (iii) the Moon differentiated into olivine, hypersthene, and basaltic and anorthositic phases, and plagioclase crystallization began after ~93% solidification, then mass balance calculations yield ~30-km and ~10-km thicknesses for the lunar highlands for the melting and chemical differentiation of the entire Moon and of the upper 200 km, respectively. Corresponding thicknesses of the basaltic basement rocks were ~5 km and ~2 km, respectively. Alternatively, if the anorthosites of this study are representative of the highlands and the onset of plagioclase crystallization occurred after ~50% solidification of the initially melted Moon, calculations with REE and Ba partition coefficients suggest that the REE and Ba abundances in the primeval Moon were similar to those observed in basaltic achondrites. (auth)

7126 ORIGIN OF LUNAR ROCKS. Vinogradov, A. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geochem. Int. (Engl. Transl.); 7: No. 1, 1-11(Oct 1970).

Translated from Geokhimiya; No. 1, 3-14(Jan-Feb 1970).

Modern data, including analyses of the Apollo-11 samples, indicate that the rocks of the lunar surface crystallized from sili-

cate melts formed in the depths of the Moon by selective melting of lunar matter. It follows from this that, contrary to a widely held view, the Moon is not homogeneous. Lunar rocks contain 16% Fe and are enriched in such lithophile elements as Ti, Zr, RE, and some others, as compared with the primitive terrestrial basalts and Ca-rich feldspathic achondrites. The high content of FeO in silicate form in the lunar matter and the isomorphous relationship of Fe, Ti, and Zr in ortho- and metasilicates explain enrichment of the less refractory fraction of lunar matter in Ti and Zr. The composition of the Apollo-11 samples, so far as the essential components are concerned, most nearly resembles the composition of feldspathic achondrites (eucrites). Calculations show that the existence of a metal core in the moon is improbable, and the origin of mesosiderites is of exceptional interest in this connection. Several variants of the origin of lunar matter are discussed and it is shown that chondrites rich in silicate iron and poor in metal are its most probable source. The possibility that lunar surface rocks, with the composition of Ca-feldspathic achondrites have fallen on the Earth as meteorites cannot be disregarded. (auth)

7127 LOW-FREQUENCY RADIO EMISSION FROM JUPITER. Zabriskie, F. R. (Pennsylvania State Univ., University Park). Astron. J.; 75: 1045-51(Nov 1970).

Radio observations of Jupiter obtained at frequencies between 3 and 8 MHz are described. It is found that radiation may be received whatever the longitude of the central meridian (LCM), but the emission is stronger and more likely when LCM is near 30°, 170°, or 330°. Furthermore, it is found that the flux density decreases below 5 MHz, and that Jupiter's emission appears strongest at about 8 to 10 MHz. (auth)

7128 ANALYSIS OF THE INTENSITY FLUCTUATIONS PRODUCED BY THE INTERACTION OF THE DECAMETRIC RADIO EMISSION FROM JUPITER WITH THE INTERPLANETARY MEDIUM. Thompson, Dale Lee. Tallahassee; Florida State Univ. (1969). 196p. University Microfilms Order No. 70-16,351.

Thesis.

Interplanetary scintillation of the Jovian decametric radio emission by electron density inhomogeneities in the solar wind is considered for solar elongations of Jupiter greater than 90°. Under the circumstance, physical conditions appear to be favorable for quantitative specification of the statistical properties of the observed intensity fluctuations in terms of the character of the extended field of electron density inhomogeneities. The probability distribution of the intensity fluctuations is shown to be the Rice distribution whose parameters are specified in terms of the statistical distribution of the dimensions and magnitudes of the electron density irregularities. In addition, the intensity and phase fluctuation spectra are obtained as a function of the spectrum of the extended field of electron density irregularities. The results of a limited number of observations of the decametric radio emission at spaced sites and at a single site are also presented. The spaced-site observations indicate that the electron density irregularities are anisotropic and suggest that they are elongated along the solar magnetic field lines frozen into the radially expanding solar wind. The distributions of intensity strongly imply that the observed fluctuations are, in fact, imposed on the decametric emission by irregular diffraction in the interplanetary medium, but that their magnitudes are jointly determined by the probability distribution and intrinsic source variations on the same time scale as the interplanetary scintillations. The drift velocity of the electron density irregularities is found to be on the order of 560 km/sec. (Diss. Abstr. Int., B)

7129 CIRCULAR POLARIZATION OF JUPITER'S DECIMETRIC EMISSION AND THE JOVIAN MAGNETIC FIELD STRENGTH. Komesaroff, M. M.; Morris, D.; Roberts, J. A. (Commonwealth Scientific and Industrial Research Organization, Sydney). Astrophys. Lett.; 7: 31-6(Nov 1970).

Measurements are presented of the circular polarization of Jupiter's decimetric emission and its variation with System III longitude. The frequency dependence of the circular polarization suggests that the proportion of electrons in flat helices increases with energy. The theoretical calculations of Gleeson et al. (1969) and Clarke (1970) are used to deduce an equatorial magnetic field of 0.4 to 1.9 gauss in the radiation belt. (auth)

Atomic and Molecular Physics

Refer also to abstract 7851.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 6633, 6694, 7433, 7475, 7492, and 7504.

7130 (ORNL-TM-3163) ELECTRON ATTACHMENT TO POLYATOMIC MOLECULES. Christodoulides, A. A.; Christophorou, L. G. (Oak Ridge National Lab., Tenn.). Dec 1970. Contract W-7405-eng-26. 218p. Dep. NTIS.

Thesis. Submitted by A. A. Christodoulides to Univ. of Tennessee, Knoxville.

Interactions of low-energy electrons (below 10 eV) with key polyatomic molecules were studied. Experimental data on dissociative electron attachment to brominated aliphatic hydrocarbons of the form n-$C_NH_{2N+1}Br$ (N = 1 to 6,8, and 10) and on nondissociative electron attachment to p-benzoquinone ($C_6H_4O_2$), obtained by the electron-swarm, the electron-beam, and the swarm–beam methods, are presented and discussed within the framework of the resonance scattering theory. Indications were provided from experimental results that the n-$C_NH_{2N+1}Br$ molecules can be treated as diatomic-like molecules as far as the fast production of Br^- is concerned. However this model is not easily reconciled with infrared data on the C–Br vibrational frequencies for N > 3. Experimental evidence is presented, which indicates that electrons can be captured in the field of an excited electronic state of p-benzoquinone forming a long-lived negative ion. In addition, experimental results are presented, which provide a comparison of the electron energy distribution functions for the gases Ar, N_2, and C_2H_4. These three gases with the respective electron energy distribution functions tested are suggested as standard carrier gases for electron attachment studies. (auth)

7131 CALCULATION OF THE YIELD OF SECONDARY NEUTRONS IN THE INTERACTION OF ACCELERATED ELECTRONS WITH MATTER. Logunov, V. N.; Mal'kov, V. V.; Roslik, S. F.; Shtivel'man, A. Ya. This paper was summarized in At. Energ. (USSR); 28: 235(Mar 1970) as paper No. 374/5434. (In Russian).

Results of a calculation of the neutron yield from targets of optimum thickness bombarded by accelerated electrons are presented. For convenience in calculating the attenuation of the neutron flux in a shield, the spectrum of the neutrons emerging from a target is divided into two groups: fast (with energies from 1 keV to 20 MeV) and ultrafast (with energies above 20 MeV). Questions for the experimental study of the yield of secondary neutrons are formulated. (TSS)

7132 CALCULATION OF SELF-ABSORPTION IN β SOURCES. Belyaev, A. A.; Krupman, A. I. This paper was summarized in At. Energ. (USSR); 28: 238(Mar 1970) as paper No. 379/5492. (In Russian).

Knowledge of the energy spectra of β sources is necessary for the solution of many practical problems. The difference between the spectra of such sources and the "ideal" β spectra is due to the self-absorption of β particles in the source and their scattering in the protective coating. Two methods for calculating self-absorption are given: the first, proposed by Weymouth (Phys. Rev., 84: 766(1951)) is based on the approximate solution of the kinetic equation; the second, proposed here, is based on the Monte Carlo method. These two methods are compared by calculating the self-absorption of a $^{90}Sr-^{90}Y$ source. Using both methods, the self-absorption factors and the energy spectra of the $^{90}Sr-^{90}Y$ source were calculated by taking into account self-absorption and the protective coating, which had a thickness of 0.0135 g/cm^2. (TSS)

7133 INFLUENCE OF TARGET SURFACE STRUCTURE ON MEDIUM-ENERGY ION SCATTERING. Soszka, W. (Jagellonian Univ., Krakow). Acta Phys. Pol.; A38: 723-30(Nov 1970).

The energy distributions of 30-keV Ar^+ ions scattered on the surface of a copper single crystal were examined with reference to the azimuthal angle of target revolution, sliding angle, and angle of scattering. It was experimentally shown that the surface and deep-lying close-packed atomic rows cause some of the outlet angles to be blocked for ions scattered on the mentioned rows of atoms. There is also a discussion on the role of the semi-open surface channels in this phenomenon. (auth)

7134 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 5, NO. 8, 1970. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 54p.

This listing includes 195 articles on various aspects of surface and vacuum physics. (M.O.W.)

7135 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 5, NO. 9, 1970. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 55p.

XUM

This listing includes 187 articles on various aspects of surface and vacuum physics. (M.O.W.)

7136 BACKSCATTERING OF ELECTRONS OF DIFFERENT ENERGIES FROM SEMI-INFINITE BARRIERS. Akkerman, A. F.; Botvin, V. A.; Nikitushev, Yu. M. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 6, 65-73(Nov-Dec 1969). (In Russian).

Coefficients of backscattering were calculated by the Monte Carlo method according to the number of particles and energies of electrons for energies of 0.4, 0.6, 1.0, 1.5, and 2.0 MeV for angles of 0, 30, 45, 60, and 75° from semi-infinite barriers of carbon, aluminum, titanium, copper, tin, and lead. Using techniques of "splitting" and "tapping" for the first time, calculations were expedited and more reliable energy spectra of the backscattered electrons were obtained. For electrons <2 MeV, calculations agreed satisfactorily with experimental results; for greater energies, systematic variation (in the direction of underestimating) of calculations when compared with experimental results was observed. (tr-auth)

7137 CHANNELING OF POSITRONS IN SINGLE CRYSTALS. Didenko, A. I.; Vorob'ev, S. A.; Tsekhanovskii, I. A. JETP Lett. (USSR) (Engl. Transl.); 12: 209-10(20 Sep 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 310-11(20 Sep 1970).

Positrons from ^{22}Na were used to observe experimentally the influence of positron channeling on backscattering from single crystals. The dependence of the measured counting rate of the positrons scattered through 150° on the orientation of KCl, KBr, and KI crystals relative to the direction of incidence of the primary beam is shown. A minimum in the counting rate was observed when the direction of incidence of the primary beam coincided with the (100) direction of the target crystal. The channeling efficiency, determined by the depth of the observed minimum, increased with increasing atomic number of the target. This agrees with the conclusions of Linhard's channeling theory. (A.G.W.)

7138 BREMSSTRAHLUNG CROSS SECTIONS FOR Al AND Au FOR INCIDENT-ELECTRON ENERGIES OF 0.05 AND 0.20 MeV. Rester, D. H. (Ling-Temco-Vought, Inc., Dallas); Edmonson, N.; Peasley, Q. Phys. Rev., A; 2: 2190-5(1 Dec 1970).

Comparisons of theoretical electron-bremsstrahlung cross sections for Al and Au from the work of Brysk, Zerby, and Penny are made with new experimental values at incident-electron energies of 0.05 and 0.20 MeV. Photon energies of 10, 20, 30, and 40 keV are considered in the angular region from 10 to 120 deg at 0.050-MeV incident-electron energy. Photon energies of 46, 76, 106, 166, and 196 keV for Al and 80, 120, and 160 keV for Au are considered at 0.20-MeV incident-electron energy. Agreement between experiment and theory is within experimental error except at small angles and low photon energy. (auth)

7139 INELASTIC ATOMIC SCATTERING OF 0.1-, 0.2-, 0.4-, AND 3.0-MeV ELECTRONS. Missoni, G.; Dick, C. E.; Placious, R. C.; Motz, J. W. (National Bureau of Standards, Washington, D. C.). Phys. Rev., A; 2: 2309-17(1 Dec 1970).

Spectral data obtained with a magnetic spectrometer are presented for inelastic electron scattering from thin targets of carbon, copper, and gold at incident electron energies of 0.1, 0.2, 0.4, and 3.0 MeV, for scattering angles between 20° and 120°. For angles less than 90°, each spectrum consists of (a) a Møller line which has a half-width that increases with atomic number and which yields an experimental cross section that agrees within experimental error with the theoretical Møller cross section, and (b) a low-energy continuum that rises steeply at energies less than 40 keV. For angles greater than 90°, the Møller line that is kinematically forbidden vanishes, but the steeply rising continuum remains. This continuum may arise from single electron–atom scattering and from multiple scattering in the target. The latter process depends on target thickness. The experimental results for this low-energy continuum tend to confirm that the multiple-scattering effects as calculated by Ford and Mullin dominate the single-scattering process as calculated by Weber, Deck, and Mullin, and by Kolbenstvedt and Cooper even for an 11-$\mu g/cm^2$ carbon target, which was the most favorable case for studying the single-scattering process. Because of multiple scattering, accurate experimental data for the low-energy continuum produced by single electron–atom inelastic scattering can best be obtained with gas targets. (auth)

7140 ADDENDUM TO IMPACT-PARAMETER DEPENDENCE OF INNER-SHELL VACANCY PRODUCTION BY HEAVY-ION BOMBARDMENT. Stein, H. J.; Lutz, H. O.; Mokler, P. H.; Sistemich, K.; Armbruster, P. (Kernforschungsanlage, Juelich, Ger.). Phys. Rev., A; 2: 2575(1 Dec 1970).

The impact-parameter dependence of L-shell vacancies in the collision of 30-MeV I ions with Te atoms was remeasured with improved accuracy. (auth)

7141 ATTENUATION COEFFICIENTS OF GASES FOR 4.5- TO 145-keV PHOTONS. McCrary, J. H. (EG and G, Inc., Las Vegas, Nev.); Looney, L. D.; Constanten, C. P.; Atwater, H. F. Phys. Rev., A; 2: 2489-97(1 Dec 1970).

Narrow-beam mass-attenuation coefficients were measured for air, neon, argon, krypton, and xenon. Radioisotope sources were used to provide photons whose energies were 4.508, 5.895, 9.243, 27.380, 44.229, 88.09, and 145.43 keV. Experimental errors were less than 2% for all measurements. The experimental results are compared with theoretical predictions of the attenuation coefficients. (auth)

7142 ION EXCITATION OF CHARACTERISTIC X RAYS FOR ELEMENTS WITH $72 \leq Z \leq 92$. Needham, P. B. Jr.; Sartwell, B. D. (Bureau of Mines, College Park, Md.). Phys. Rev., A; 2: 1686-92(Nov 1970).

A systematic study was made of the ionization cross sections for ion excitation of the M-shell x rays of elements with Z in the region $72 \leq Z \leq 92$. Protons, H_2^+ ions, and α particles with incident energies ranging from 60 to 400 keV were used to excite the M lines of Hf, Ta, W, Au, Bi, and U. The Z dependence of the proton-excited x-ray yield for these elements, although differing sharply from previously published M-shell results, is shown to be consistent with the Z dependence for proton excitation of the K and L shells reported in earlier papers. Finally, the ionization cross sections of H_2^+ ions at incident energy E_0 are compared with those for protons at incident energy $\frac{1}{2} E_0$, and it is found that within 30% they are in the ratio 2:1. (auth)

7143 X RAYS FROM μ, π, κ, AND Σ^- CAPTURE IN THE LIGHT ELEMENTS. Berezin, S. (Argonne National Lab., Ill.).; Burleson, G.; Eartly, D.; Roberts, A.; White, T. O. Phys. Rev., A; 2: 1630-51(Nov 1970).

A search for x rays from the capture of kaons in helium disclosed neither K- nor L-series radiation; the upper limit of the x-ray yield is in the range 7 to 10%. This contradicts results of an earlier measurement, but is in better agreement with related data on kaon–helium scattering. In the same experimental arrangement, the yields of pionic and muonic x rays in helium were also measured. Anomalously low yields were found, accompanied by intensity distributions of the K-series members in disagreement with the conventional cascade picture of a predominantly circular set of orbits. Monte Carlo cascade calculations could not duplicate the observed results unless weak Stark mixing, in the form of "sliding transitions" $(n, l \rightarrow n, l \pm 1)$, was added. Agreement with observation was achieved in muonic, pionic, and kaonic atoms with a single value for the parameter describing the strength of the Stark mixing. Yields and energies of kaonic x rays in other light elements, Li, Be, and C, were also measured. Yields of x rays from muonic and pionic capture in these elements were remeasured also, and cascade calculations like those for helium repeated. In these elements the addition of Stark mixing is not needed to achieve agreement with experiment. In the pionic atoms 2p-state absorption rates and in kaonic atoms 3d-state absorption rates for He, Li, Be, and C can be derived from the experimental data and compared with theoretical values with good agreement. In addition to the identifiable kaonic transition lines also observed by Wiegand and Mack, additional lines not ascribable to kaonic atoms were found in all three elements. After careful consideration of possible origins of these lines, the two lithium lines are ascribed to Mα and Mβ, and the Be line to Mα transitions in Σ-hyperonic atoms. Such atoms are formed if Σ^- hyperons from kaon capture (whose abundance is about 15%) are slowed down and stopped in the target. The observed yields and energies are consistent with this interpretation, and with no other known to the authors. A line in C, however, cannot be ascribed either to kaonic or Σ atoms, and appears to be a pionic Lα. Why such a line appears only in C is not understood. (auth)

Atomic and Molecular Properties

Refer also to abstracts 7087, 7485, 7486, 7487, and 7806.

7144 (TID-25588) HANLE EFFECT IN 2^1P HELIUM. Fry, Edward Strauss (Michigan Univ., Ann Arbor). 1969. 32p. Dep. NTIS.

Thesis.

The oscillator strength for the resonance ($1^1S - 2^1P$) transition in atomic helium was determined from a measurement of the lifetime of the 2^1P state. This lifetime was obtained using a modified zero-field level-crossing (Hanle) method. The scattering sample was a thermal-velocity beam of 2^1S metastable atoms. Resonant

$2\text{-}\mu$ (2^1S-2^1P) radiation is absorbed by the 2^1S atoms, which are excited to the 2^1P state. This state then primarily decays to the ground 1^1S state with the emission of resonance (584-Å) radiation. The lifetime of the 2^1P state was determined from measurements of the magnetic-field dependence of the 584-Å intensity. This new technique eliminates the problem of constructing a vacuum ultraviolet resonance lamp. The measured lifetime $\tau(2^1P)$ is $(5.69 \pm 0.23) \times 10^{-10}$ sec. The resulting absorption oscillator strength for the resonance transition is 0.270 ± 0.011. This oscillator strength agrees with the theoretical value. (auth)

7145 (UCRL-19530, pp 191-220) ATOMIC AND MOLECULAR SPECTROSCOPY. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

Projects on which progress are reported include the following: atomic polarizabilities for the first excited ^2D state of Al, Ga, In, and Tl; atomic-beam measurement of the isotope shifts of ^{41}K and ^{42}K relative to ^{39}K; hyperfine structure of the 4103-Å line of In; calculation of nonrelativistic wave functions of complex atoms using modifications of the Tietz potential; analysis of the spectrum of Dy I; atomic energy levels of Bk, Cf, and Es; formation and spectra of Es ions in CaF_2; γ-induced thermoluminescence of Tm, Er, Ho, Am, Cm, and Pu ions in CaF_2; Moessbauer study of protactinium oxides; diffusion of Li in W; L x-ray emission from ^{252}Cf fission fragments slowing down in Cu. (A.G.W.)

7146 THEORETICAL INTERPRETATION OF THE $4f^6 6s$ AND $4f^4 5d$ CONFIGURATIONS OF Nd II. Wyart, Jean-Francois (CNRS, Orsay, France). J. Phys. (Paris); 31: 559-64(Jul 1970). (In French).

The classification of the Nd II spectrum led to the discovery of 47 new low levels belonging to the $4f^6 6s$ and $4f^4 5d$ configurations. The theoretical calculation of the energy eigenvalues and the Lande g factors of the two configurations taken together allowed the interpretation of the 78 experimental levels with a rms error of 57 cm^{-1}. Eigenvectors are given in the LS scheme. The values of the radial parameters were fitted by the least-squares method. (auth) (France)

7147 SOME CONSIDERATIONS ON RARE-EARTH ACTIVATED PHOSPHORS. Blasse, G. (Philips Research Labs., Eindhoven, Netherlands). J. Lumin.; 1-2: 766-77(1970).

From International Conference on Luminescence, Newark, Del. See CONF-690840-(Vol.1 and 2).

A review is given of some of the investigations on rare-earth activated phosphors carried out in the years 1966-1969. (auth)

7148 L_2- AND L_3-SUBSHELL FLUORESCENCE YIELDS FOR $Z > 37$. Bhalla, C. P. (Kansas State Univ., Manhattan). Phys. Rev., A; 2: 2575-7(1 Dec 1970).

The relativistic calculation of radiative widths for the K shell and L subshells, as reported by Scofield, are in agreement (within 0.1%) with the present independent calculations. Theoretical total K-shell widths (x ray + Auger) are presented as a function of the atomic number. Using the experimental widths of $K\alpha_1$ and $K\alpha_2$ and our theoretical results, calculated L_2- and L_3-subshell fluorescence yields are presented versus atomic number. (auth)

7149 STARK-INDUCED QUANTUM BEATS IN H Ly_α EMISSION. Andrae, H. J. (Univ. of Arizona, Tucson). Phys. Rev., A; 2: 2200-7(1 Dec 1970).

Intensity beats in the emission of Ly_α from beam-foil-excited hydrogen in various static electromagnetic field configurations were studied. The observed beat frequencies agree with the calculated values, which are independent of the field directions. The beat amplitudes, however, show significant dependence on the field directions relative to the beam. The theory for emission of light from the decay of coherently excited states is applied to the sudden perturbation limit. Agreement with experiment can only be obtained under the assumption that the foil excitation generates initial coherent wave functions $\Psi_{I,II} = \alpha|p, 1/2, \pm 1/2\rangle + \beta|s, 1/2, \mp 1/2\rangle$, where $|l, j, m_j\rangle$ notation and the beam as quantization axis are used. The ratio α/β is then determined, which gives the ratio of the excitation cross section of the p to that of the s states as $\sigma_p/\sigma_s \geq 4 \pm 1$ at a beam energy of 200 (keV) per atom. (auth)

7150 LIFETIMES OF 3p, 4p, AND 5p STATES IN ATOMIC HYDROGEN. Etherton, R. C.; Beyer, L. M.; Maddox, W. E.; Bridwell, L. B. (Murray State Univ., Ky.). Phys. Rev., A; 2: 2177-9(1 Dec 1970).

Beam-foil excitation was used to populate the 3p, 4p, and 5p states in atomic hydrogen in order to measure their mean lives. The results were 5.41 ± 0.18, 11.25 ± 0.78, and 21.9 ± 3.0 nsec, respectively. All three decay curves displayed a long-lived component. It was found that compensation must be made for Rutherford scattering in order to avoid introducing significant errors. An experimental technique for eliminating these errors is presented. (auth)

7151 METHOD FOR ONE PARTICLE BOUND TO TWO IDENTICAL FIXED CENTERS: APPLICATION TO H_2^+. Jasperse, J. R. (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Rev., A; 2: 2232-44(1 Dec 1970).

A method is presented for the quantum-mechanical problem of one particle moving in the field of two identical fixed centers. An equation for the problem is derived in both position and momentum space as a special limiting case of our general method for the three-body problem. When applied to the H_2^+ problem, using the Coulomb-Sturmian set as an expansion basis, the method gives an infinite secular equation for the energy eigenvalues which can be solved exactly in the limits as the internuclear distance goes to zero and to infinity. Numerical results are also reported for the energy as a function of internuclear distance for the $1\sigma_g$, $1\sigma_u$, $2\sigma_g$, and $2\sigma_u$ states of H_2^+. (auth)

7152 FOURTH-ORDER ELECTRODYNAMIC CORRECTIONS TO THE LAMB SHIFT. Appelquist, Thomas; Brodsky, Stanley J. (Stanford Univ., Calif.). Phys. Rev., A; 2: 2293-2303(1 Dec 1970).

The fourth-order radiative correction to the slope at $q^2 = 0$ of the Dirac form factor of the free-electron vertex is calculated using computer techniques. The result $m^2 \partial F_1^{(4)}(0)/\partial q^2 = (\alpha/\pi)^2 (0.48 \pm 0.07)$ disagrees with previous calculations and implies a new theoretical value for the order $\alpha^2(Z\alpha)^4 mc^2$ contribution to the Lamb shift. The new values for the $2S_{\frac{1}{2}} - 2P_{\frac{1}{2}}$ separation in H and D are increased by 0.35 ± 0.07 MHz and are in good agreement with the results of recent experiments. (auth)

7153 MANY-BODY PERTURBATION THEORY FOR THE HYDROGEN NEGATIVE ION. Dutta, N. C.; Dutta, C. M.; Das, T. P. (Univ. of Utah, Salt Lake City). Phys. Rev., A; 2: 2289-92(1 Dec 1970).

Linked-cluster many-body perturbation theory is applied to study the stability of the ground state of the H^- ion. A diagrammatic approach is made to analyze the role of various polarization effects. A complete set of states obtained in the V^{N-1} potential is used to evaluate the diagrams. The total energy of H^- is calculated to be $-0.027\ 66$ a.u., leading to the binding energy $0.527\ 66$ a.u., in good agreement with the most accurate value, $0.027\ 75$ a.u., due to Pekeris. The result of our investigation shows conclusively the crucial importance of monopole and dipole polarization effects for the stability of this ion in particular and negative ions in general. A comparison with the results from earlier work is also made. (auth)

7154 COEFFICIENTS CONNECTING THE STARK AND FIELD-FREE WAVEFUNCTIONS FOR HYDROGEN. Tarter, C. Bruce (Univ. of California, Livermore). J. Math. Phys. (N. Y.); 11: 3192-5(Nov 1970).

A general expression for the coefficients connecting the Stark (parabolic coordinates) and field-free (spherical coordinates) wave functions for hydrogen is obtained. The result, which involves a generalized hypergeometric function, has been numerically evaluated through principal quantum number $n = 10$. (auth)

7155 DETERMINATION OF IONIZATION POTENTIALS OF ATOMIC URANIUM BY ELECTRON IMPACT METHOD. I. MEASUREMENT OF FIRST IONIZATION POTENTIAL OF URANIUM. Emel'yanov, A. M.; Khodeev, Yu. S.; Gorokhov, L. N. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 279-82(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 296-9(Mar-Apr 1970).

The electron impact method was used in conjunction with a mass spectrometer to obtain single-ionization curves for atomic uranium. The curves of the effectiveness of single ionization of uranium revealed thermal excitation of neutral atoms. The value found for the first ionization potential of uranium was 6.19 ± 0.06 eV. (auth)

7156 TRANSITIONS $(1s2p)^3P^0 - (2p^2)^3P^e$ IN He AND $(2s2p)^3P^0 - (2p^2)^3P^e$ IN H^-. Bhatia, A. K. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., A; 2: 1667-8(Nov 1970).

Precision calculations of the energies of the $(2p^2)^3P^e$ states of He and H^- are carried out with a Hylleraas-type wave function and are the lowest variational results yet obtained. The associated wave functions are used to calculate the mass polarization of the state. With the reduced mass correction, the wave numbers of the transitions $(1s2p)^3P^0 - (2p^2)^3P^e$ in He and $(2s2p)^3P^0 - (2p^2)^3P^e$ in H^- are found to be 312222 and 3783 cm^{-1}, respectively. This former value is in disagreement with the experiment of Kruger

(1930) who obtained 312118 cm^{-1}. The discrepancy between the experimental and theoretical values of 100 cm^{-1} is large enough to encourage renewed experimental observation. (auth)

7157 PARAMETERS OF DEEP ODD CONFIGURATIONS IN THE I AND II SPECTRA OF GADOLINIUM. Wyart, Jean-Francois (CNRS, Orsay, France). Compt. Rend., Ser. B; 271: 849-52 (19 Oct 1970). (In French).

The methods of Racah were used to study the deep odd configurations from the spectra of Gd I and Gd II. A new interpretation of the $4f^7\ (5d + 6s)^3$ and the $4f^7\ (5d + 6s)^2$ was found. A definite improvement in the agreement between the theoretical and experimental results was shown when terms arising from $4f^7\ {}^6P^0$ were introduced into the calculation. (auth) (France)

7158 HYPERFINE STRUCTURE OF $^5I_{8,7}$ ATOMIC STATES OF ^{161,163}Dy AND THE GROUND-STATE NUCLEAR MOMENTS. Childs, W. J. (Argonne National Lab., Ill.). Phys. Rev., A; 2: 1692-1701(Nov 1970).

The atomic-beam magnetic-resonance technique was used to measure the hyperfine structure of the $4f^{10}6s^2\ ^5I_{8,7}$ atomic states of ^{161,163}Dy. Values of the hyperfine-interaction constants A, B, and C, corrected for hyperfine interactions with other states, are given for both atomic states of each isotope. It is found that for the nuclear ground states of ^{161,163}Dy, $\mu^{163}/\mu^{161} = -1.400(3)$, and, less accurately, $\mu^{163} = +0.65(6)\mu_N$, $Q^{163} = +2.51(30)$ b, $\mu^{161} = -0.46(5)\mu_N$, $Q^{161} = +2.37(28)$ b. The electron g factor g_J is measured for the atomic states $4f^{10}6s^2\ ^5I_{8,7,6}$ and also for the lowest $J = 8$ level of $4f^95d6s^2$ at 7565 cm^{-1}. The lifetime of this level cannot be appreciably less than 2 msec, the transit time for the atom in the apparatus. (auth)

7159 CALCULATIONS OF 3S-10S STATES OF He. Perkins, J. F. (Army Missile Command, Redstone Arsenal, Ala.). Phys. Rev., A; 2: 1701-3(Nov 1970).

Nonrelativistic energies and mass-polarization shifts of 3S-10S states of He were calculated with 40- to 80-term Rayleigh-Ritz expansions in r_1, r_2, and r_{12}. Pekeris's calculated values of relativistic shifts were used in making comparisons with experimental values. Except for 8 ^1S, the calculated ionization energies are less than the experimental values (in agreement with variational principle) by amounts ranging from 0.01 cm^{-1} upward. (auth)

7160 ELECTRON MOMENTUM DENSITY OF He AND H_2: COMPTON X-RAY SCATTERING. Eisenberger, P. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., A; 2: 1678-86 (Nov 1970).

The electron momentum density (EMD) of the electrons in the helium atom and hydrogen molecule was measured by Compton x-ray scattering. The results for helium, in both the liquid and gaseous state, are in agreement within the statistical accuracy of the experiment with Hartree-Fock calculations of the EMD. For the hydrogen molecule the effects of binding on the EMD are clearly observed. There is disagreement between Hartree-Fock calculations of the EMD for the hydrogen molecule and the measured EMD. This disagreement is attributed to non-Hartree-Fock electron-electron interaction effects, which are sizable in the H_2 molecule. In addition, for these systems, further proof of the validity of the impulse approximation is obtained by an accurate measurement of the Compton shift. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 7856.

7161 STRUCTURE OF NEUTRAL MESONIC ATOMS FORMED IN LIQUID HELIUM. II. CORRECTIONS TO THE BINDING ENERGY. Russell, J. E. (Univ. of Cincinnati). Phys. Rev., A; 2: 2284-9(1 Dec 1970).

Corrections are made to a previous computation of the binding energies of some highly excited states of the $\alpha\pi^-e^-$ and αK^-e^- atoms. The corrections take into account the effects of two approximations made in the original calculation. These approximations are (i) the use of the Born-Oppenheimer approximation in describing the radial motion of the meson with respect to the α particle and (ii) the use of a variational wave function to describe the motion of the electron. The corrections are found to be too small to have any significant effect on existing estimates of Auger rates for circular orbits. In each instance that is considered, the total correction to the energy difference between a circular and an almost circular orbit with the same principal quantum number is found to be only a few percent at most. (auth)

7162 PROPERTIES OF THE π^--^{4}He ATOM AS DETERMINED FROM LOW-ENERGY π^--^{4}He SCATTERING PHASE SHIFTS. Boyd, J. H. (Illinois Inst. of Tech., Chicago). Phys. Rev., A; 2: 2186-90(1 Dec 1970).

An effective-range analysis is used to predict properties of the π^--^{4}He atom. The method produces precise predictions; however, the predictions are broadened because of systematic differences between phase shifts from the various scattering experiments. The bounds obtained for the 1s and 2p level shifts (due to the strong interaction) are 90 to 160 eV (toward less binding) and (-2.4 to -4.0) $\times 10^{-3}$ eV, respectively. The bounds obtained for the nuclear capture rates from the 1s and 2p states are (0.12 to 1.8) $\times 10^{17}$ sec^{-1} and (0.46 to 4.0) $\times 10^{12}$ sec^{-1}, respectively. The results are consistent with mesonic x-ray measurements. (auth)

7163 ANNIHILATION OF POSITRONS IN NITROGEN. Tao, S. J. (New England Inst., Ridgefield, Conn.). Phys. Rev., A; 2: 1669-75(Nov 1970).

The positron annihilation lifetime spectra in nitrogen were measured by a new apparatus consisting of two time-to-amplitude converters. The annihilation of positrons in nitrogen as a function of nitrogen densities from 2 to 45 amagats was investigated. The free annihilation rate was found to be 5.80 ± 0.07 μsec^{-1} $amagat^{-1}$, and the o-Ps quenching rate, 0.22 ± 0.06 μsec^{-1} $amagat^{-1}$. Both rates were found to be linear for densities up to 45 amagats. A distinctive shoulder was observed in the positron annihilation lifetime spectra for nitrogen with densities less than 10 amagats. The shoulder width is estimated to be 14 ± 3 nsec amagat. The value of Z_{eff} for free-positron annihilation at thermal energy is found to be 30. The value of Z_{eff} for free-positron annihilation at energy about 0.5 eV or higher is estimated to be only about 23. (auth)

Collision Phenomena

Refer also to abstracts 7025 and 7789.

7164 STUDY OF THE POLARIZATION OF He DE-EXCITATION LIGHT UNDER H-ION IMPACT AT MEDIUM ENERGY. Grouard, Jean-Pierre; Hirszowski, Julien; Lefebure, Patrick; de Palmas, Henri (Univ., Paris). Compt. Rend., Ser. B; 271: 622-5(28 Sep 1970). (In French).

A measurement of the polarization for the 4^1D-2^1P, 4^3S-2^3P, 3^3D-2^3P lines of He excited by impact of H^+, H_2^+, and H_3^+ ions was made in the 15- to 40-keV energy range. (auth) (France)

7165 OSCILLATIONS OF EXCITATION FUNCTION OF HELIUM RESONANCE LINE AND INTERFERENCE OF TWO VACANT STATES IN COLLISIONS OF Na^+ IONS WITH HELIUM. Bobashev, S. V.; Kritskii, V. A. (Ioffe Inst. of Physics and Tech., Moscow). JETP Lett. (USSR) (Engl. Transl.); 12: 189-90(20 Sep 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 280-2(20 Sep 1970).

The intensities Q_1 of the 584.3-Å He I resonance line excited in the reaction $Na^+ + He \rightarrow Na^+ + He(2p^1P^0)$ were measured. The values of Q_1 obtained were plotted in units of the reciprocal velocity of the relative motion of the colliding partners and compared with a similar plot for excitation of the yellow doublet of Na I in the reaction $Na^+ + He \rightarrow Na^+(3p^2P_{\frac{1}{2},\frac{3}{2}}) + He^+$. It is suggested that the structure of both curves is due to interference of the two inelastic channels of the reactions. The absolute value of the cross section for the excitation of the 584.3-Å He I line is estimated to be 7×10^{-19} cm^2 at an Na^+ ion energy of 11.5 keV. (A.G.W.)

7166 INFLUENCE OF EXCITATION OF H_2^+ AND D_2^+ ON THE CROSS SECTION FOR THEIR DISSOCIATION IN COLLISIONS WITH ATOMS AND MOLECULES IN THE ENERGY REGION FROM 0.1 TO 2 keV. Tunitskii, N. N.; Zhurkin, E. S.; Tikhomirov, M. V. JETP Lett. (USSR) (Engl. Transl.); 12: 210-12(20 Sep 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 312-14(20 Sep 1970).

Total dissociation cross sections were measured for weakly vibrationally excited H_2^+ ions in collisions with H_2, for weakly vibrationally excited D_2^+ ions in collisions with D_2 and Ne, and for strongly vibrationally excited D_2^+ ions in collisions with Ne at energies of 0.1 to 2 keV. The dissociation cross sections for the weakly excited ions increased monotonically with kinetic energy. The cross sections for the strongly excited ions decreased with increasing energy. It follows that dissociation at low energies is more sensitive to the excitation of the initial ions than dissociation at high energies. (A.G.W.)

7167 STUDY OF PRODUCTION OF IONS BY THE PENNING EFFECT. Sinda, T. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 33A: 225-6(2 Nov 1970). (In French).

The production of ions by interaction of a beam of metastable atoms (He or Ne) with various target gases (H_2, Ar, Kr) was studied. Penning ionization cross-section values were deduced by comparison with the values of electron ionization cross sections. They are compared with values obtained in previous experiments. (auth)

7168 IMPULSE APPROXIMATION FOR ONE-DIMENSIONAL ATOM–OSCILLATOR COLLISIONS. I. Clinton, William L.; Cosgrove, Cristine M.; Henderson, George A. (Georgetown Univ., Washington, D. C.). Phys. Rev., A; 2: 2357-67(1 Dec 1970).

Translational–vibrational energy transfer in collinear collisions of an atom and a harmonic oscillator has been treated in the impulse approximation of Chew. Although transition probabilities for a soft exponential interaction potential compared poorly with exact quantum mechanical results, for sufficiently small incident masses good results were obtained for a hard impulsive interaction. This is understood in terms of the ratio of the collision time to the oscillator period; the impulse approximation is expected to be valid when this ratio is small. For the smaller incident masses, qualitative agreement with exact results was obtained over a wide energy range for the "hard-sphere" collisions. This represents the first successful approximate treatment of impulsive collisions for this model. In contrast to the familiar perturbative methods, the quality of the approximation does not decrease for multiple-quantum transitions and improves as the energy increases. The one-dimensional impulse-approximation transition probabilities P_{if} are ill behaved at threshold; however, most computed probabilities remained well behaved to within about $\frac{1}{4}\hbar\omega$ of threshold. The approximation fails to conserve probability. It was found that the sums of probabilities $\Sigma_f P_{if}$ for the various initial states i provided reliable measures of confidence in the approximation. For a given i, if the probability sum was nearly constant with changing energy, the P_{if} curves were qualitatively good; on the contrary, the curves were in less good agreement with exact results if the probability sums were less stable with changing energy. When the curves for a given i were qualitatively good, a simple renormalization yielded quantitative agreement with exact results and minimized the effects of threshold misbehavior. (auth)

7169 FORMATION AND DESTRUCTION OF EXCITED HYDROGEN ATOMS AT HIGH IMPACT VELOCITIES. Edwards, J. L.; Thomas, E. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., A; 2: 2346-56(1 Dec 1970).

A study was made of the charge-transfer processes whereby fast neutral atoms of hydrogen are formed in the 3s, 3p, and 3d excited states as a result of the impact of protons on targets of helium and of nitrogen. Impact energies ranged from 75 to 400 keV. The experimental procedure involved quantitative measurement of the Balmer α radiation emitted by the spontaneous decay of atoms in these three states. The three contributions to the emission were separately identified according to the different lifetimes of the 3s, 3p, and 3d states by a time-of-flight technique. A study was also made of the processes whereby the excited atoms were collisionally destroyed before undergoing spontaneous radiative decay. Detailed measurements are presented of the cross sections for capture into the 3s state, which are by far the largest of these capture cross sections. Cross sections for capture into the 3p and 3d states are one to two orders of magnitude smaller, and preliminary measurements are discussed. All of these cross sections decrease rapidly with increasing impact energy. There is general agreement between the present measurements and the predictions of the Born approximation for capture into the 3s and 3d states from a target of helium, but the calculation for the 3p state appears to overestimate the cross section by a factor of at least 4. The cross sections for collisional destruction of atoms in the 3s state are several orders of magnitude larger than for electron capture into this state, and the magnitude of the measured values is in agreement with theoretical predictions. (auth)

7170 EXCITATION OF HIGHLY IONIZED ATOMS BY ELECTRON IMPACT. Golshani, Mehdi (Univ. of California, Berkeley). Phys. Rev., A; 2: 2340-6(1 Dec 1970).

The Coulomb–Born approximation is used to calculate the total cross section for the electron-impact excitation of ionized atoms that have one electron outside their closed shells. When the incident energy is high and the atom is highly ionized, the eikonal and classical approximations can be used in conjunction with the Coulomb–Born approximation. Then, the scattering amplitude reduces to a one-dimensional path integral. The path integral, in turn, can be reduced, to any desired accuracy, to a sum over integrals that can be evaluated analytically. By this procedure, the total cross sections for the heavily ionized atoms Fe^{15+}, Co^{16+}, Ni^{17+}, and Cu^{18+} were calculated. (auth)

7171 ELASTIC DIFFERENTIAL SCATTERING OF LOW-ENERGY H^+ BY RARE-GAS ATOMS. Champion, R. L.; Doverspike, L. D.; Rich, W. G.; Bobbio, S. M. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev., A; 2: 2327-34(1 Dec 1970).

Elastic scattering experiments were performed on the systems $H^+ + Kr$, $H^+ + Ar$, $H^+ + Ne$, and $H^+ + He$ with collision energies between 3 and 60 eV. For each of the above systems the experimental differential cross section $\sigma(\theta)$ at one of the lower energies (typically 4 or 6 eV) was compared with the results of a partial-wave calculation where the JWKB method was used to find the phase shifts and consequently the differential cross section. For the systems KrH^+, NeH^+, and ArH^+ an analytical form was chosen for V(r), and parameters (e.g., the well depth U and the value r_m of the internuclear separation for which the potential is a minimum) in this model were varied until the calculated $\sigma(\theta)$ agreed quite well with the experimental results. In the case of $H^+ + He$ two ab initio calculations of the interatomic potential V(r) are available, and each was used in the JWKB expression to determine the differential cross section. For one of the potentials the predicted $\sigma(\theta)$ is in striking agreement with the experiment. This method is seen, therefore, to provide a sensitive test of such calculations when they exist. (auth)

7172 CROSS SECTION FOR EXCITATION OF THE FOURTH POSITIVE BAND SYSTEM IN CARBON MONOXIDE BY 20- TO 120-keV PROTONS. Park, John T.; Schoonover, D. R.; York, George W. (Univ. of Missouri, Rolla). Phys. Rev., A; 2: 2304-8 (1 Dec 1970).

Excitation cross sections for the fourth positive band system in carbon monoxide were determined from studies of the energy-loss spectra of 20- to 120-keV protons incident on gaseous CO targets. The energy-loss spectra had an energy resolution of about 2 eV. Prominent peaks in the spectra were observed at 8.5 and 13.8 eV. The first peak is believed to be due to excitation of the fourth positive band system of CO ($X^1\Sigma^+ \rightarrow A^1\Pi$), while the 13.8-eV peak covers a number of possible states, including the $B^1\Sigma^+$ and the $C^1\Sigma^+$ states. Changes in the slope of the ionization continuum were noted at 16.5 eV, corresponding to the $A^2\Pi_i$ state of CO^+, and at 20.5 eV, corresponding to the $B^2\Sigma^+$ state of CO^+. Absolute excitation cross sections for the fourth positive band system of CO are presented, as well as the total inelastic cross sections and the total ionization cross sections for 20- to 120-keV protons incident on CO. (auth)

7173 STRUCTURE OF O_2. Boness, M. J. W.; Schulz, G. J. (Yale Univ., New Haven). Phys. Rev., A; 2: 2182-6(1 Dec 1970).

Measurements of the differential cross section for the elastic scattering of low-energy electrons by O_2 at 50° exhibit structure resulting from the compound state O_2^-. From these observations the spectroscopic constants of the ground state $^2\Pi$ of O_2^- are calculated, and the values $\omega_e(O_2^-) = 1089\ cm^{-1}$ and $r_e(O_2^-) = 1.377$ Å are found. A portion of the potential-energy curve of the $O_2^-(^2\Pi_g)$ is plotted using the Morse-function representation and the calculated values of the spectroscopic constants. (auth)

7174 VACUUM ULTRAVIOLET RADIATION AND JESSE EFFECTS IN THE NOBLE GASES. Hurst, G. S.; Stewart, T. E.; Parks, J. E. (Univ. of Kentucky, Lexington). Phys. Rev., A; 2: 1717-20(Nov 1970).

When charged particles interact with the noble gases, energy is radiated in the vacuum ultraviolet (vuv) region of the electromagnetic spectrum. Some recent measurements of the absolute yield of vuv energy per cm of proton track length show that this quantity $d\epsilon/dx$ is an appreciable part of the total stopping power dE/dx. Here, it is shown by direct comparisons and by arguments based on the principle of conservation of energy that the Jesse effect (Penning ionization) in helium, neon, and argon is associated with radiation energy in the vuv region. (auth)

7175 ASYMPTOTIC DOUBLE-PHOTOEXCITATION CROSS SECTIONS OF THE HELIUM ATOM. Aberg, T. (Uppsala Univ.). Phys. Rev., A; 2: 1726-9(Nov 1970).

A relative cross section for simultaneous excitation and ionization of the helium atom is derived from the sudden approximation. It is shown to agree with that obtained from the velocity form of the cross section in the Coulomb approximation. It is connected to the asymptotic cross section of Kabir and Salpeter through the cusp condition at the nucleus. An analysis of the influence of ground-state correlations on the asymptotic double-excitation cross section is carried out. (auth)

7176 NEW METHOD FOR LOW ENERGY (0 TO 10 eV) ION-GAS TOTAL CROSS SECTIONS USING AN ELECTROSTATIC REPULSION TECHNIQUE. Martin, D. H.; Davis, D. A.; Christian, W. (North Carolina State Univ., Raleigh). Rev. Sci. Instrum.: 41: 1803-9(Dec 1970).

A method is described for measurement of low-energy total cross sections using an analysis of the uncollided portion of the

beam by electrostatic repulsion. Instead of energy separation of the initial beam, a (retarded) spectrum of energies (0 to 10 eV) is accepted and analyzed with and without interactions. The method applies, in principle, to energies arbitrarily close to zero, limitations occurring in beam intensity and in the smallness of energy group treated in the associated computer analysis. A further limitation is that only large-angle scattering is measured. Test measurements for argon ions in argon gas show total cross sections above 1 eV to be indistinguishable from quoted values of charge transfer. In the vicinity of 1 eV a steep rise in cross section is observed. (auth)

7177 POLARIZATION OF THE $L\alpha_1$ X RAYS OF MERCURY. Hrdý, J.; Henins, A.; Bearden, J. A. (Johns Hopkins Univ., Baltimore, Md.). Phys. Rev., A; 2: 1708-11(Nov 1970).

The polarization of the $L\alpha_1$ characteristic x rays of mercury was measured with respect to the emission plane. A mercury-vapor-target x-ray tube was used with a jet density such that most electrons encountered only a single exciting collision. A quartz crystal ($23\bar{5}4$) plane, which diffracted the $L\alpha_1$ line (1.241 20 Å*) at an angle $2\theta = 104°$, was used as the analyzer. The observed polarization was $(-14 \pm 4)\%$. (auth)

7178 RETARDATION IN THE ELASTIC SCATTERING OF PHOTONS BY ATOMIC HYDROGEN. Gavrila, M. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.); Costescu, A. Phys. Rev., A; 2: 1752-8(Nov 1970).

The matrix element for the elastic scattering of photons by atomic hydrogen is evaluated analytically in closed form in the nonrelativistic case including retardation. The method of integration is similar to the one used previously by one of the authors for the dipole approximation. It is based on the possibility of expressing the matrix element in terms of the Green's function for the Coulomb field, for which the momentum-space integral representation derived by Schwinger and others is then used. Some integrations yield the matrix element in terms of essentially two hypergeometric functions of Appell's type F_1, with variables and parameters depending on the photon energy. A discussion of the result is given. (auth)

7179 POLARIZATION OF LYMAN-α RADIATION PRODUCED BY DIRECT EXCITATION OF HYDROGEN ATOMS BY PROTON IMPACT. Kauppila, W. E.; Teubner, P. J. O.; Fite, W. L.; Girnius, R. J. (Univ. of Pittsburgh). Phys. Rev., A; 2: 1759-63(Nov 1970).

The polarization of Lyman-α radiation resulting from the direct excitation of hydrogen atoms by proton impact was measured in the energy range 2 to 21 keV. A Brewster's angle polarization analyzer was used to measure the polarization of the observed Lyman-α radiation. The results are compared with the four-state Sturmian calculation of Gallaher and Wilets. (auth)

7180 POLARIZATION OF LYMAN-α RADIATION PRODUCED IN CHARGE-TRANSFER COLLISIONS BETWEEN PROTONS AND THE INERT GASES. Teubner, P. J. O.; Kauppila, W. E.; Fite, W. L.; Girnius, R. J. (Univ. of Pittsburgh). Phys. Rev., A; 2: 1763-7(Nov 1970).

The polarization of Lyman-α radiation arising from charge-transfer collisions between protons and helium, argon, and neon was measured for incident proton energies from 0.6 to 24 keV. A lithium fluoride crystal set at the Brewster's angle was used to measure the polarization of the radiation. Structure was observed in the energy dependence of the polarization fraction for $H^+ - Ne$ and $H^+ - Ar$ collisions, which reflect the structure in the total cross sections for electron capture into the 2P state of atomic hydrogen for these collisions. The present results are in poor agreement with those of Gaily et al. (auth)

7181 EXCITATION OF THE $(2p^2)^3P$ STATE OF HELIUM NEAR THRESHOLD. Burrow, P. D. (Yale Univ., New Haven). Phys. Rev., A; 2: 1774-8(Nov 1970).

The trapped-electron method is applied to the excitation by electron impact of the $(2p^2)^3P$ state, the lowest doubly excited state of helium that is stable against auto-ionization. The energy of this state, 59.64 ± 0.08 eV, is in good agreement with theory. An estimate of the slope of the total cross section for excitation of the $(2p^2)^3P$ state at threshold gives a value of 4×10^{-20} cm^2/eV. (auth)

7182 FREDHOLM METHOD. II. A NUMERICAL PROCEDURE FOR INELASTIC SCATTERING. Reinhardt, William P. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 2: 1767-74 (Nov 1970).

A convenient and accurate numerical method is given whereby inelastic scattering information can be obtained by construction of the Fredholm determinant $\det[1 - \underline{G}(E + i\epsilon)\underline{V}]$ for the coupled Lippmann–Schwinger equations. The method is noniterative and is easily applied when the potential matrix is nonlocal or energy-dependent. It is shown that the determinant $\det[1 - \underline{G}(E + i\epsilon)\underline{V}]$ may be factored as $\det[1 - \underline{PG}(E)\underline{V}]\det(1 - i\underline{R})$ when $\underline{PG}(E)$ is the principal-value Green's function and R is the usual R matrix of principal-value Lippmann–Schwinger theory; the R matrix may be obtained from $\det[1 - \underline{G}(E + i\epsilon)\underline{V}]$ by a single partial triangularization. As a simple example of the extraction of the R matrix from the Fredholm determinant, the problem of electron scattering from hydrogen atoms is considered in the 1s, 1s–2s, 1s–2s–3s, and 1s–2s–3s–4s close-coupling approximations. The use of optical potentials in the Fredholm theory is discussed: The two-channel problem originally suggested by Huck is solved numerically by construction of an optical potential. (auth)

7183 VIBRATIONAL EXCITATION IN ELECTRONICALLY EXCITED IONS PRODUCED BY CHARGE EXCHANGE. Haugh, Michael J.; Bayes, Kyle D. (Univ. of California, Los Angeles). Phys. Rev., A; 2: 1778-85(Nov 1970).

The charge-exchange reactions between Ar^+ or Kr^+ and several molecules were studied spectroscopically. Light emission is observed from the molecular ions, indicating near-resonant charge exchange. Measurements on mixtures of gases provide relative cross sections for the formation of electronically excited ions. The cross sections are largest for the smallest energy defect, in agreement with the theory of Rapp and Francis. The Franck–Condon principle is not a dominant factor in determining the populations of different vibrational levels of diatomic ions, but it may be important for triatomic ions. (auth)

7184 DIFFERENTIAL SCATTERING OF HELIUM IONS ON TARGETS OF He, Ne, AND Ar AT ENERGIES FROM 120 TO 830 keV. Taylor, G. O.; Thomas, E. W.; Martin, D. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., A; 2: 1785-94(Nov 1970).

The scattering of He^+ projectiles by impact on the noble gases He, Ne, and Ar was investigated in the energy range 120 to 830 keV under single-collision conditions. Specifically, the experiment measured, as a function of angle in the range 1° to 8°, the total differential scattering cross section as well as the differential cross sections for scattering without change of charge, for scattering with charge transfer, and for scattering with electron stripping. The total differential scattering cross section was found to be in agreement with a theoretical differential scattering cross section calculated classically using a screened Coulomb potential. Thus, the scattering of the particles in these close encounters is determined primarily by the mutual nuclear repulsion and may be adequately described by classical mechanics. The fraction of particles in a particular charge state was independent of the scattering angle, a result consistent with theory and with previous experiments at slightly lower energies. For the resonant case $He^+ + He$, it was found that the fraction of scattered particles that had picked up an electron during the collision could be predicted by a semiempirical equation. Good agreement was also found when comparing relative charge-state populations with the predictions of a statistical theory. (auth)

7185 MEASUREMENTS OF EXCITED-STATE POPULATION RATIOS OF ATOMIC HYDROGEN PRODUCED BY CHARGE-EXCHANGE NEUTRALIZATION OF ENERGETIC PROTON BEAMS. McFarland, Robert H.; Futch, Archer H. Jr. (Univ. of California, Livermore). Phys. Rev., A; 2: 1795-1801(Nov 1970).

Excited-state population ratios for atomic hydrogen were measured for energetic hydrogen ions neutralized by charge exchange with a number of different metallic vapors and permanent gases. Electric-field ionization techniques were used to determine excitation ratios. Detection of the energetic ions and neutrals was accomplished using partially depleted surface-barrier detectors. Counting, using phase-detection techniques in which an add–subtract scaler was phased to the signal, provided an improved signal-to-noise ratio. Two methods were used to provide desired targets. Metallic vapor and permanent-gas thin targets of the order of 10^{-5} mtorr cm were produced as chopped neutral beams, using conventional crossed-beam techniques. Gas cells were used to extend these measurements with permanent gases to targets up to seven orders of magnitude thicker. In the latter case, the ion beam was interrupted electrically. Targets investigated were magnesium, potassium, barium, hydrogen, nitrogen, thallium, Freon, water vapor, ammonia, and perfluorodimethylcyclohexane (C_8F_{16}). (auth)

Atomic Theory

Refer also to abstracts 7151, 7586, and 7693.

7186 SPECTRAL CONCENTRATION FOR THE HELIUM SCHROEDINGER OPERATOR. Rejto, P. A. (Univ., Geneva. Univ. of Minnesota, Minneapolis). Helv. Phys. Acta.; 43: 652-67(1 Oct 1970).

It is shown that the phenomenon of spectral concentration also holds for the family of Schroedinger operators corresponding to helium in an electric field. A summary is given of facts about the Schroedinger operator. The abstract concentration theorem is then applied to the family of Schroedinger operators corresponding to helium in a weak homogeneous electric field. (M.O.W.)

7187 STATISTICAL ATOMIC MODEL WITH ELECTRON CLUSTERING AT (nl) SUBSHELLS. Tarasov, V. F.; Chanyshev, S. M. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 6, 58-65(Nov-Dec 1969). (In Russian).

Several models of a statistical atom with division of the electrons according to subshells are suggested. One of the models, using a hydrogen-type function as trial function for the radial distribution of the electron density, was verified using krypton and palladium atoms as examples. Calculations obtained by a computer are compared to other data. (tr-auth)

7188 NUMERICAL SOLUTION OF THE (1s1s) AND (1s2s) HYDROGENIC PAIR EQUATIONS. Winter, Nicholas W. (Battelle Memorial Inst., Columbus, Ohio); McKoy, Vincent. Phys. Rev., A; 2: 2219-31(1 Dec 1970).

The pair functions that determine the exact first-order wave function for the ground state of the three-electron atom were found with the matrix finite-difference method. The second- and third-order energies for the $(1s1s)^1S$, $(1s2s)^3S$, and $(1s2s)^1S$ states of the two-electron atom are presented along with contour and perspective plots of the pair functions. (auth)

7189 NONPERTURBATIVE APPROACH TO THE THEORY OF TRANSITION PROBABILITIES. Wallace, R. (Univ. of Manitoba, Winnipeg). Phys. Rev., A; 2: 1711-16(Nov 1970).

A nonperturbative approach to the theory of transition probabilities is presented. The results of this theory are employed to investigate the validity of the assumptions inherent in the perturbative approach. For this purpose, the simple examples of absorption of radiation (first-order process) and Raman scattering (second-order process) are used. The method proposed, which is based upon finite-difference techniques, represents an accurate solution of the time-dependent Schrödinger equation in a given representation and has many advantages over methods based upon the perturbation series. (auth)

7190 COOPERATIVE PHENOMENA IN RESONANT ELECTROMAGNETIC PROPAGATION. Arecchi, F. T. (Laboratori Centro Informazioni Studi Esperienze, Milan. Univ., Milan); Courtens, Eric. Phys. Rev., A; 2: 1730-7(Nov 1970).

Phenomena of coherent resonant propagation can be considered as resulting from the cooperative interaction of a certain number of excited two-level systems. It is shown that these phenomena can be characterized by a specific "maximum cooperation number" and by the associated "cooperation time." These are defined for the superradiant state, but their meaning and usefulness can be extended to other situations. The alternative description of superradiance as a spontaneous or as a stimulated effect is also discussed and it is shown that with the help of the new concepts, the Dicke quantum perturbative treatment can be reconciled with the semiclassical theories. (auth)

7191 LOWER-BOUND METHOD FOR ATOMIC CALCULATIONS. Kijewski, L. J. (Monmouth Coll., West Long Branch, N. J.); Percus, J. K. Phys. Rev., A; 2: 1659-64(Nov 1970).

In the reduced-density-matrix variational method, a trial density matrix $\Gamma_t^{(2)}$ is varied subject to physical realizability conditions in order to calculate the ground-state energy $E_0 = \frac{1}{2}N$ min $\mathrm{Tr}\bar{H}^{(2)}\Gamma_t^{(2)}$. Here $\Gamma_t^{(2)}$ is expanded in a finite basis of Hartree–Fock geminals and number of equalities are applied to reduce the parameter space of $\Gamma_t^{(2)}$. The method is completely general, but application is made only to the C^{++} ion, where a six-geminal expansion coupled with positivity of $\Gamma_t^{(2)}$ recovers the Hartree–Fock result. (auth)

7192 EXCHANGE SYMMETRY OF MANY-PARTICLE STATE FUNCTIONS. Salzman, W. R. (Univ. of Arizona, Tucson). Phys. Rev., A; 2: 1664-6(Nov 1970).

A formal operator definition of indistinguishability of identical particles alternative to permutation invariance of configuration probabilities is presented. The exchange-symmetry properties of many-particle wave functions are shown to follow simply and directly from the new definition. (auth)

7193 THEOREM ON THE SCHROEDINGER EQUATION FOR ATOMS AND MOLECULES APPLIED TO THE H_2 MOLECULE. Almstroem, H. (Royal Inst. of Tech., Stockholm). Lett. Nuovo Cim.; 4: 779-82(24 Oct 1970).

The theorem considered states that, given the Schroedinger equation, there exists at least one complete denumerable orthonormal basis $\{\phi_\Gamma\}$ with the following properties: (1) ϕ_Γ is independent of the coordinates of the center of mass, (2) ϕ_Γ is an eigenfunction to $\bar{J}^2$, J_z, $\bar{L}^2$, $\bar{S}^2$, P, (3) ϕ_Γ has the same permutation properties as Ψ, and (4) all the matrix elements $\langle\phi_{\Gamma'}|H|\phi_\Gamma\rangle$ are given by easily computed finite algebraic expressions. The H_2 molecule is used as an example in demonstrating the validity of the theorem. (A.G.W.)

Cosmic Radiation

Refer also to abstracts 6579, 6932, 7007, 7098, 7099, 7114, 7537, 7538, and 7549.

7194 (NP-18515) COSMIC RAY RECORDS, WILKES 1967. Jelleff, R. O.; White, K. S. (Department of External Affairs, Melbourne (Australia). Antarctic Div.). 1969. 44p. Dep. NTIS (U. S. Sales Only).

The detailed results obtained from the continuous-recording neutron monitor at the ANARE station, Wilkes (66° 5'S, 110° 3'E; geomagnetic 78°S, 79°E) during 1967, are tabulated. (auth) (Australia)

7195 (UCI-10-P-19-38) COSMIC RAY NEUTRINO EXPERIMENT. Sandie, W. G.; Landecker, P. B.; Lathrop, J.; Sobel, H. W.; Reines, F. (California Univ., Irvine. Dept. of Physics); Bourne, D.; Sellschop, J. P. F. (University of the Witwatersrand, Johannesburg (South Africa)); Crouch, M. F. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). [1970]. 20p. (CONF-700708-1). Dep. NTIS.

From 6th Interamerican Seminar on Cosmic Rays, La Paz, Bolivia.

Preliminary results from the detector located deep underground on Level 77 of the East Rand Proprietary Mine near Johannesburg are presented. The array is described and a summary of results to date is given, including the total exposure and running time and the distribution of events in zenith angle. A few sample events are described. (auth)

7196 DIRECTIONAL COSMIC-RAY CUTOFFS AND THE LOOP-CONE PHENOMENON AT MIDLATITUDE SITES. Cooke, D. J.; Humble, J. E. (Univ. of Tasmania, Australia). J. Geophys. Res.; 75: 5961-71(1 Nov 1970).

During calculations of cutoff momentums in closely spaced directions over the observing hemisphere at six sites ranging from 26 to 47°S geomagnetic latitude, a peculiar fine structure, or folding, of the main-cone cutoff distribution was observed. This structure is in itself the boundary of a nearly circular cone within which depressed main-cone cutoff values are encountered. The detailed results of the cutoff calculations for two sites are presented to illustrate the effect, together with a general interpretation of the folding in terms of the looping of some trajectories around field lines at longitudes near the sites. As the influence of this main-cone folding on directional detector rates could be considerable, the necessity for taking inclined-direction cutoffs into account in the interpretation of latitude survey data is stressed, particularly in view of the failure of vertical cutoff values to account satisfactorily for the observed cosmic-ray intensity variation with latitude. (auth)

7197 RIGIDITY DEPENDENCE FOR FORBUSH DECREASES IN 1968 COMPARED WITH THAT FOR THE 11-YEAR VARIATION. Lockwood, J. A.; Lezniak, J.; Singh, P.; Webber, W. R. (Univ. of New Hampshire, Durham). J. Geophys. Res.; 75: 6885-91 (1 Dec 1970).

Comparisons are made of the cosmic-ray intensities measured by the Pioneer 8 detector and by ground-based neutron monitors located at different vertical cutoff rigidities for three Forbush decreases in 1968 and for the 11-year solar modulation. It is observed that the rigidity dependence of the three large Forbush decreases was substantially different than the corresponding 11-year variation at rigidities from <1 to >50 Gv. (auth)

7198 COSMIC-RAY DENSITY GRADIENT PERPENDICULAR TO THE ECLIPTIC PLANE. Swinson, Derek B. (Univ. of New Mexico, Albuquerque). J. Geophys. Res.; 75: 7303-6(1 Dec 1970).

To explain the observed solar semidiurnal cosmic-ray variation, it has been postulated that a cosmic-ray density gradient perpendicular to the ecliptic plane exists. The proposed gradient required a minimum density of cosmic rays in the ecliptic plane, with the density increasing with distance both above and below the plane. Subramanian (1970) correlated neutron monitor data to the Earth's position with respect to the solar equatorial plane, which changes in heliographic latitude during the year, indicating a cosmic-ray density increasing with distance below the ecliptic plane

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and decreasing above it during the period 1962 to 1965. An analysis is made here of cosmic-ray data that show evidence of a perpendicular cosmic-ray density gradient in the same direction that would correspond to the results of Subramanian. Cosmic-ray data from three neutron monitors and two underground μ-meson telescopes were separated according to the direction of the interplanetary magnetic field and analyzed for a solar diurnal variation. A plot is given of amplitudes of the solar diurnal variation during 1967–68 as a function of threshold rigidity for neutron monitors at Deep River, Hermanus, and Mt. Norikura, and for underground μ-meson telescopes in Bolivia and at Embudo. (J.C.W.)

7199 COSMIC-RAY ELECTRON INTENSITY OBSERVATIONS. Marsden, P. L.; Jakeways, R.; Calder, I. R. (Univ. of Leeds, Eng.). J. Geophys. Res.; 75: 7280-3(1 Dec 1970).

Results of experimental observations of the primary cosmic ray electron intensity are usually shown to establish the shape of the intensity–energy spectrum, and attempts are frequently made to fit the spectrum for energies $\gtrsim$1 GeV to a power law of the form $dJ/dE = KE^{-\gamma}$. It is suggested that results may be more simply shown if the usual log–log plots are replaced by plots in which intensities are multiplied by $E^{+\gamma}$. In this way, satellite data from the Dutch group, (Bleeker et al., 1969) and the Leeds group, (Marsden et al., 1969) and balloon data from Webber, Agrinier, Rubstov, Hovestalt, Oran, and Anand et al. are graphically presented and discussed. Values of 2.6 and 2.8 were assumed for γ. The results were not corrected for the effects of solar modulation. Neither of the assumed power laws fits the observations over the full range of energy. A discrepancy exists between the satellite and balloon observations, and it is suggested that interacting proton events are mistakenly included as electrons. (J.C.W.)

7200 GEOSTATIONARY SATELLITES AND THE ANISOTROPIES OF COSMIC-RAY PROPAGATION IN THE INTERPLANETARY MEDIUM. Gall, Ruth; Bravo, Silvia (National Univ. of Mexico, Mexico City. Comision Nacional de Energia Nuclear, Mexico City). J. Geophys. Res.; 75: 7284-9(1 Dec 1970).

Unidirectional detectors may be used to observe anisotropies of propagation in the interplanetary medium of cosmic rays, including the anisotropy along the Parker garden-hose field lines and the anisotropy due to modulation of cosmic rays that leads to the diurnal variation and lies approximately 90° east of the Sun–Earth line in the ecliptic. The use of geostationary satellites for the detection is possible if the direct mode of propagation prevails for energies above approximately 50 MeV. Directions of approach of protons arriving at satellite ATS 1 under different angles of incidence at different local times were computed for a wide spectrum of energies. Projections on the ecliptic plane for each of the approach directions were obtained. It is pointed out that observational cutoffs for anisotropies should exist, below which the anisotropies cannot be observed in the geostationary satellites. The trajectories of cosmic rays are computed by numerical integration, using a modified McCracken program in which the geomagnetic field model includes the external sources due to the currents in the magnetopause and the neutral sheet. (J.C.W.)

7201 GALACTIC COSMIC-RAY DEUTERONS AND ENERGY SPECTRA OF SOURCES. Meyer, Jean-Paul (CEN de Saclay, Gif-sur-Yvette, France). Astrophys. Lett.; 7: 61-8(Nov 1970).

The low-energy cosmic-ray deuteron flux is the sum of three components due to (i) the spallation of low-energy cosmic-ray ^{4}He (and CNO) nuclei, (ii) the spallation of ^{4}He nuclei in interstellar matter by protons of energy above $\approx$30 MeV, (iii) the reaction $p + p \rightarrow d + \pi^+$ induced by $\approx$600 MeV protons. The relative weights of these components and of the low energy ^{4}He flux give information on the relative abundance of high- and low-energy cosmic rays in interstellar space, therefore on the spectral shapes of the sources. (auth)

7202 ^{53}Mn AND THE AGE OF GALACTIC COSMIC RAYS. Reames, Donald V. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 162: 837-9(Dec 1970).

A new measurement is suggested for obtaining information on the mean age of the galactic cosmic rays. The technique is based on a half-life of $\sim 2 \times 10^6$ years for ^{53}Mn, which may be produced copiously below 200 MeV per nucleon by the fragmentation of cosmic-ray ^{56}Fe during its passage through interstellar or intergalactic hydrogen. (auth)

7203 NOTE ON THE PARALLEL DIFFUSION COEFFICIENT. Hasselmann, K. (Univ., Hamburg); Wibberenz, G. Astrophys. J.; 162: 1049-51(Dec 1970).

The gradient-induced anisotropy and the parallel diffusion coefficient are related to the pitch-angle diffusion coefficient. The treatment is more complete than that given previously by Jokipii and by Hasselmann and Wibberenz in order to show the limits of applicability and the physical meaning of divergences resulting for certain types of magnetic-field spectra. (auth)

Direct Energy Conversion

Refer also to abstracts 6898, 7385, 7386, and 8112.

7204 (IPP–6/89) CALCULATION OF THE CURRENT FLOW DIRECTIONS IN A CHANNEL WITH STAGGERED ELECTRODES UNDER MHD GENERATOR CONDITIONS. Croci, M. G.; Gorenflo, R.; Hertweck, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1970. 33p. Dep. NTIS (U. S. Sales Only).

With suitable simplication it is possible, by complex analysis, to calculate the strength and direction of the electric current flow in MHD generator configurations. In the model described, the electric current forms a plane potential flow for which an explicit expression can be given. (auth)

7205 ELIMINATION OF END LOSSES IN AN MHD INDUCTION GENERATOR. Lessmann, Richard C. (Brown Univ., Providence). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 2097-8(Nov 1970).

End losses have a marked effect on efficiency, and arise from currents induced by fringing fields associated with the finite length of the excitation current sheet. Such currents may be physically eliminated by the insertion of nonconducting baffles in the end sections; however, it is then necessary to modify the electromagnetic fields in these regions so as to maintain an ideal waveform in the device. This may be accomplished by the use of end coils. An attempt is made to provide a simple determination of the end coil currents necessary to accomplish the desired matching. The generator design is shown. (M.H.R.)

7206 ANALYSIS AND DESIGN STUDY OF THE COMPRESSIBLE, TRAVELING-WAVE, MAGNETOHYDRODYNAMIC, INDUCTION GENERATOR. Lessmann, Richard Carl. Providence; Brown Univ. (1969). 161p. University Microfilms Order No. 70-8751.

Thesis.

This type of generator is composed of an annular flow passage arranged coaxially with a set of field coils. Interaction between the traveling-wave magnetic field and the moving fluid induces ring currents, in the flow gap, which inductively couple to the field coils. The analysis of this device is based on a set of fundamental equations which are fully derived in an appendix. The time-averaged flow problem is solved for several different design cases, and nondimensional plots of the results are included. These calculations indicate that the device has a high conversion efficiency, but a low thermal efficiency, and hence may not be practical as the sole active component in a thermodynamic cycle. Also included is a study of stability in which attention is focused on axial plane-wave disturbances. A mathematically rigorous stability criterion is derived for this situation. Based on an approximation to this criterion, it is shown that while no region of parameter space is absolutely stable, maximum stability, for all disturbance frequencies, is obtained when the square of the ratio of the mean Alfven speed to the speed of sound is small. (TSS) (Diss. Abstr. Int., B)

7207 FEASIBILITY OF MAGNETOPLASMADYNAMIC EXPERIMENTS IN INDUCTIVE HYDRODYNAMIC SHOCK TUBES. Rothhardt, L. (Zentralinstitut fuer Elektronenphysik, Jena, Ger.). Beitr. Plasmaphys.; 10: 357-64(1970). (In German).

At first, the special features of the inductive-hydrodynamic type of an electromagnetic shock tube are sketched. The fast plasma flow in its expansion tube is homogeneous and free of eddy currents and distributed magnetic microfields. Therefore, it can be used for magnetoplasmadynamic studies. Modeling of MHD channels with electrodes at the wall is very difficult because of electrode effects in the low-pressure regime in use. Therefore, electrode behavior in low-pressure plasma streams was studied extensively and results are given briefly. Modeling of electrodeless MHD channels by means of the inductive-hydrodynamic shock tube is possible. A channel with ring-shaped cross section and radial magnetic field was analyzed. The results of studies on dynamics and electrodynamics in this type of channel are given. (auth)

7208 ELECTRON–ION RECOMBINATION IN SEEDED COMBUSTION PRODUCTS. Coney, M. W. E. (Central Electricity Research Labs., Leatherhead, Eng.). J. Phys., D (London); 3: 1702-12(Nov 1970).

The possibility of attaining a high nonequilibrium electrical conductivity in a high-velocity flow of combustion products is of interest from the point of view of MHD power generation. Experimental evidence and theoretical predictions of the electron–ion

recombination coefficient, which is of critical importance in this context, are discussed. An experiment is described, in which combustion products seeded with potassium were accelerated through a nozzle to a supersonic velocity. The electrical conductivity was measured and found to be a factor of six lower than that expected from the J. J. Thomson 3-body recombination theory. (auth) (UK)

7209 OPTIMUM SEEDING OF HELIUM WITH CAESIUM IN MHD POWER GENERATORS. Guha, S. (Indian Inst. of Tech., New Delhi). J. Phys., D (London); 3: 1713-16(Nov 1970).

The optimum seeding of helium with cesium in a linear MHD generator was investigated for three different electrode configurations; taking into account the dependence of electron collision cross sections on electron velocity. The result shows that the optimum ratio α of the number of cesium to helium atoms not only depends upon the electron temperature but also on the electrode geometry. The expressions for the electron temperature for all the three electrode geometries are derived. Numerical results are presented from which the optimum ratio α and the electron temperature can be obtained for the relevant range of parameters. (auth) (UK)

7210 INFLUENCE OF END EFFECTS ON THE THERMAL EFFICIENCY OF MHD PLANTS. Vatazhin, A. B.; Medin, S. A.; Sokol'skii, A. G.; Shumyatskii, B. Ya. (Inst. of High Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 372-80 (Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 403-11(Mar-Apr 1970).

The problem of the current and potential distributions in the end region of a sectional MHDG (magnetohydrodynamic generator) with an alternating magnetic field is solved. For the case of a magnetic field falling exponentially outside of the electrode zone, formulas are obtained for calculating the increments of the power and the dissipation with respect to their values with a one-dimensional distribution of the parameters. A method is developed, and calculations are made of the characteristics of a MHDG taking end effects into account. A determination is made of the change in the efficiency of a combination MHD–steam-turbine power plant due to end effects, with variation of the profile of the magnetic field in the end region, of the preheating temperature of the air, the ratio of the sides of the cross section of the channel, the induction of the magnetic field, and the flow rate. (auth)

7211 CRITICAL CURRENT DENSITY THROUGH ZrO_2–Y_2O_3 CERAMIC OF A MHD GENERATOR. Gokhshtein, Ya. P.; Safonov, A. A. (Inst. of High Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 368-71(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 398-402(Mar-Apr 1970).

In samples of $ZrO_2-Y_2O_3$ in an air atmosphere there exists a determined critical current level, above which mechanical failure of the sample sets in. The process of cracking of the sample starts at the cathode. The critical current level coincides with a lag on the current–potential curves; this criterion can be used in practice for selection of the permissible current through an actual sample and for control of the state of the sample during the working process. (auth)

7212 INTERNAL EFFICIENCY OF THE VAPOR–LIQUID ACCELERATION DEVICE OF A LIQUID-METAL MHD UNIT. Shpil'rain, E. E.; Yakimovich, K. A.; Sevast'yanov, A. P. (Inst. of High Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 364-7(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 394-7(Mar-Apr 1970).

The problem of evaluating the efficiency of a vapor–liquid-acceleration device in a power plant with a liquid-metal MHD generator is considered. A determination of the internal relative efficiency of the injector is presented as an element of the overall power scheme. A simple analytical expression is obtained for calculating the efficiency of the circuit as a whole in terms of the relative efficiencies of the individual elements. (auth)

7213 CONVERSION OF K_2CO_3 INTO $KHCO_3$ IN THE LOW-TEMPERATURE ZONE OF THE GAS LOOP OF A MHD GENERATOR. Golubkova, A. S.; Zakharova, N. I.; Laricheva, M. A.; Mostinskii, I. L.; Nekhoroshev, R. S. (Inst. of High Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 433-4 (Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 459-60(Mar-Apr 1970).

A study was made of the possible conversion of K_2CO_3 (ionizing additive) to $KHCO_3$ in combustion products in an experimental MHD generator. The K_2CO_3 was introduced in the form of dispersed powder, and samples of the additive were removed from the stream of combustion products and analyzed by titration. The results show ~80% conversion at ~80°C, dropping with temperature; the upper limit for $KHCO_3$ formation is near 160°C. At higher temperatures, the whole additive exists in the form K_2CO_3. (D.L.C.)

Fluid Physics

Refer also to abstract 6468.

7214 (BNL-14004) THERMAL-ENTRY REGION HEAT TRANSFER IN MAGNETOHYDRODYNAMIC CHANNEL FLOW SUBJECT TO AXIAL CONDUCTION AND THE BOUNDARY CONDITION OF THE THIRD KIND. Hsu, Chia-Jung; Lindauer, George C. (Brookhaven National Lab., Upton, N. Y.). Aug 1969. 11p. Dep. NTIS.

Thermal-entry-region heat transfer in an MHD channel was studied for the boundary condition of the third kind, considering Joule heating, viscous dissipation, and axial conduction. To allow for the effect of axial conduction at $x = 0$, the fluid temperature was taken to be uniform at $x = -\infty$, and the first 20 eigenconstants were computed for the regions $x \leq 0$ and $x \geq 0$, separately. Both the temperatures and temperature gradients were matched at $x = 0$ by constructing a pair of orthonormal functions from the non-orthogonal eigenfunctions. From the temperature solutions, the effects of Hartmann number, electric field factor, radiation, and heat-generation parameters, as well as Peclet number, on the local Nusselt number were examined. (auth)

7215 REFLECTION AND REFRACTION OF MAGNETO-HYDRODYNAMIC WAVES AT A LIQUID–SOLID INTERFACE, WITH APPLICATIONS TO THE EARTH'S CORE. Skiles, Durward DeWitt. Berkeley, Calif.; Univ. of California (1969). 190p. University Microfilms Order No. 70-13,170.

Thesis.

The reflection and refraction of plane MHD waves at a fluid/solid interface is investigated by matching the inhomogeneous electromagnetic plane wave solutions in a finitely conducting solid with the homogeneous MHD plane wave solutions in a semi-infinite fluid of infinite conductivity, zero viscosity, and zero compressibility. Both fluid and solid are permeated by a constant magnetic field $\vec{H}_0$ of arbitrary orientation with respect to the fluid/solid interface. The solution in the solid represents a single refracted wave whose amplitude decays with distance from the boundary with a penetration depth $\delta_2 \geq 1/\sqrt{2\pi\sigma\omega}$, the classical "skin depth" in a conducting solid. In the fluid the solution consists of an incident wave, a reflected wave, and a surface disturbance that decay with distance from the boundary and that carry no energy in a direction normal to the boundary. In deriving the law of reflection, $\cot\theta_1 = \cot\theta_0 + 2\tan\beta\cos\gamma$, and the complex law of refraction, it is found that the incident, reflected, and refracted waves are coplanar and that the incident and reflected waves must always project in opposite directions along $\vec{H}_0$. If the incident MHD wave is polarized either perpendicular or parallel to the plane of incidence, both the reflected and refracted waves have the same polarization as the incident wave. The energy associated with an MHD wave of arbitrary polarization flows along $\vec{H}_0$ and is the sum of the energies in the perpendicular and parallel polarizations. The energy flux in the perpendicular polarization is identical with the electromagnetic Poynting vector, whereas that in the parallel polarizations is the sum of the Poynting vector, which is in the direction of the phase propagation vector, and a pressure flux term $p\vec{v}$, which is normal to the phase propagation vector. The energy transmission coefficients are given by equations (4.50) and (4.52) and are such that $T_\perp \geq T_\parallel$, $T_\perp = T_\parallel$ at normal incidence, and $T_\perp = T_\parallel = 0$ if and only if (i) $\vec{H}_0$ is parallel to the fluid/solid interface or (ii) the incident wave is normal to $\vec{H}_0$. The transmission coefficients are evaluated numerically and the theory is applied to the Earth's core and lower mantle. For a wide range of values of the parameters, and specifically for periods of 1 to 1,000 years (corresponding to the geomagnetic secular variation), and for a solid conductivity of 10^{-9} to 10^{-8} emu, a fluid density of 11 gm/cm^3, a magnetic field of 5 to 500 gauss, and arbitrary orientations of the incident wave and magnetic field, $T_\perp$ and $T_\parallel$ are quite frequently greater than 0.5 and almost always greater than 0.1. The presence of the magnetic field renders the conducting fluid highly anisotropic, and as a result, the transmission of westward moving waves into the mantle is favored, thus offering a possible explanation for the observed westward drift of the nondipole component of the geomagnetic field. (Diss. Abstr. Int., B)

7216 TURBULENT FLOW AND HEAT EXCHANGE OF ELECTRICAL-CONDUCTING FLUIDS IN MAGNETIC FIELDS. Petukhov, B. S.; Zhilin, V. G. (Inst. of High-Temperatures, Moscow). Inzh.-Fiz. Zh.; 19: 548-61(Sep 1970). (In Russian).

XUM

Certain latest achievements in theoretical and experimental studies of turbulent MHD flow are reviewed and various equations used in the studies are included. Semi-empirical theory of turbulent flow of conducting fluid in a magnetic field is discussed, considering the Hartmann turbulent flow, turbulent flow in a longitudinal magnetic field, and the turbulent transfer of momentum. (55 references) (R.V.J.)

7217 EFFECT OF A LONGITUDINAL MAGNETIC FIELD ON THE STABILITY OF THE FLOW OF AN ELECTRICALLY CONDUCTING LIQUID. Genin, L. G.; Zhilin, V. G.; Manchkha, S. P. (Inst. of High Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 428-30(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 454-7(Mar-Apr 1970).

Friction resistance coefficient measurements were carried out on mercury in an experimental section in which water's laminar–turbulent transition occurs at Re = 11,000. In the first series of experiments, conducted without a turbulizing ring, the flow remained laminar up to Re = 10^4, and a magnetic field did not have any effect. With a turbulizing ring in the inlet cone, the laminar–turbulent transition occurred at Re ~ 3000, but a magnetic field stabilizes the laminar flow up to Re ~ 5000. (D.L.C.)

7218 ELECTROHYDRODYNAMIC BULK INSTABILITY OF A SLIGHTLY CONDUCTING FLUID BETWEEN TWO COAXIAL CYLINDERS WITH A SMALL TEMPERATURE GRADIENT. Kim, Kuh; Lee, Chung Oh; Kim, Chul Soo (Seoul National Univ.). J. Phys. Soc. Jap.; 29: 1625-34(Dec 1970).

The bulk instability of a viscous, incompressible, slightly conducting, dielectric fluid contained between two coaxial cylinders with a radial temperature gradient and under a radial electric field is dealt with theoretically. A gradient in electrical conductivity resulting from the temperature gradient causes free charges to accumulate in the fluid when the electric field is applied. In the case considered, the gradient in dielectric constant can be neglected with the significant electric force being that due to the free charges. It is found that the stability criteria depend on the magnitude of the imposed potential, temperature gradient, fluid properties, and geometrical configuration. In solving the stability problem by the linear perturbation theory, it is assumed that the motion due to instability is two-dimensional and stationary. The limiting cases when the electrical conductivity goes to infinity or zero are discussed. (auth)

7219 HYDROMAGNETIC STABILITY OF FREE FLOWS AT LARGE REYNOLDS NUMBERS. IV. FREE TWO-DIMENSIONAL JET. Nakata, Isamu (Osaka Univ.). J. Phys. Soc. Jap.; 29: 1619-25(Dec 1970).

The effects of an aligned uniform magnetic field upon the stability of a two-dimensional jet of an incompressible, electrically conducting fluid with small magnetic Prandtl number are investigated for flows of large Reynolds numbers. The condition for stability is obtained as a relation between the wave number, the Reynolds number, and the Alfvén number for small magnetic Prandtl number. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 7052, 7053, and 7429.

7220 DIRECT MEASUREMENTS OF ELECTRON ENERGY DISTRIBUTIONS IN THE DAYTIME IONOSPHERE. Huang, Philip Tsung-fu. College Park, Md.; Univ. of Maryland (1969). 102p. University Microfilms Order No. 70-12,926.

Thesis.

The energy distributions of electrons in the ionospheric plasma were obtained for the energy interval of 0 to 15 eV, from the utilization of a pulse probe operated in the dc mode. The experiments were conducted aboard four sounding rockets (NASA 14.164, 18.12, 14.298, and 18.30), launched from Wallops Island, Virginia into normal daytime ionospheres. The observed retarded current–voltage characteristics indicate the existence of two distinct distributions in this energy range, the thermal distribution and a secondary distribution extending to approximately 8 eV at the higher altitudes, with characteristic temperatures of ~1.5 to 2.5×10^3K and 1 to 3×10^4K, respectively. Both temperatures, are observed to increase with increasing altitudes in the region between ~120 and 240 km. The retarded-probe currents corresponding to these two distributions are exponential functions of the retarding-probe potential. No valleys or humps were observed to exist in the secondary energy distribution function. The concentration of secondary electrons has the approximate values of 150 to 200 electrons/cm^3 between ~150 and 240 km. A high-energy electron component ($E \geq 15$ eV) in the ambient plasma was observed to have contributed to the total probe current. The retarded probe current from this distribution appears as a linear function of the retarding probe potential. Analysis of the magnitudes and the slopes of the measured current indicate characteristic energies of ~26 eV, with a concentration between 5 to 14 electrons/cm^3, the latter increasing with increasing altitudes. (Diss. Abstr. Int., B)

7221 PROTON MICROBURSTS. Dave, Anil. San Diego, La Jolla, Calif.; Univ. of California (1969). 86p. University Microfilms Order No. 70-13,675.

Thesis.

A rocket observation of auroral protons during a substorm shows that their distribution function of the perpendicular energy repeatedly develops a large peak near 20 keV that is unstable over a time scale of a few hundred milliseconds; the repetition rate of the instability is between 3 and 10 Hz, and bursts of the integrated electron flux above 3 keV are associated with this. The altitude variation of the energetic protons above 20 keV implies a distribution function strongly peaked perpendicular to the magnetic field for these particles. The necessary conditions for the onset of a Type A electrostatic ion-cyclotron instability appear to be met, although a conclusive identification is not possible. Electromagnetic-noise emission must result from these large, millisecond modulations of the energetic protons, the proton microbursts, many of which show high-frequency structure approaching the local proton gyrofrequency. (Diss. Abstr. Int., B)

7222 PHOTOMETRIC MEASUREMENT OF THE VERTICAL DISTRIBUTION OF HELIUM AND SOME DEVELOPMENT OF THE SUPPORTING RADIATIVE TRANSFER THEORY. Kumer, John Berg. Pittsburgh; Univ. of Pittsburgh (1969). 223p. University Microfilms Order No. 70-12,841.

Thesis.

The overhead intensity of the 584-A resonance line of helium in the day airglow was measured as a function of height between 400 and 1000 km on July 12, 1966 by a retarding potential analyzer that was mounted on a rocket launched from Wallops Island, Virginia. Essentially the measuring technique involved analyzing the energy spectrum of photoelectrons produced by ultraviolet skylight. The radiative transfer theory supporting the analysis of the experiment is developed in detail. The comparison of the experimental 584-A intensity profile with theoretical profiles showed the best fit for the total resonance optical thickness above 185 km to be approximately 10, corresponding to a column density of helium above 185 km equal to 8.6×10^{13}/cm^2. Within the bounds of experimental error the measured helium number density distribution was identical to that predicted by assuming diffusive equilibrium. Upper and lower limits were found for the half width of the solar 584-A emission line. It was found to lie in the range $.015 \text{ A} \leq \Delta\lambda_s \leq .024 \text{ A}$. The intensity profile of the 1216 A hydrogen Lyman-α line was also measured. (Diss. Abstr. Int., B)

7223 PROTON FLUXES AT 300 keV ASSOCIATED WITH PROPAGATING INTERPLANETARY SHOCK WAVES. Armstrong, T. P. (Univ. of Kansas, Lawrence); Krimigis, S. M.; Behannon, K. W. J. Geophys. Res.; 75: 5980-8(1 Nov 1970).

Proton, α particle, and $Z \geq 3$ nuclei flux enhancements occurring in intimate temporal association with 4 propagating interplanetary shocks observed by the Explorer 33 and 35 spacecrafts in 1967–1968 are described. The events are all characterized by anisotropic fluxes and rapid (<1.5 min) temporal fluctuations. Shock effects were observed for protons, α particles, and $Z \geq 3$ nuclei. Electron effects (>50 keV) were sought, but none were detected. We conclude that the observed effects are probably due in part to the acceleration of charged nuclei in the interplanetary medium by some process involving the interplanetary shock. (auth)

7224 OBSERVATIONS AND INTERPRETATION OF THE LUNAR MACH CONE. Whang, Y. C. (Catholic Univ. of America, Washington, D. C.); Ness, N. F. J. Geophys. Res.; 75: 6002-10 (1 Nov 1970).

The existence of a lunar Mach cone in the flow of the magnetized warm collisionless solar plasma was determined from magnetometer data on lunar Explorer 35. The axis of the Mach cone indicates that the direction of the solar wind comes from ~4.5° west of the Sun as viewed from the Moon. Owing to the variability to the magnetic field direction, the spacecraft actually observed the three-dimensional wake region of the interaction of the solar wind with the Moon. The lack of axial symmetry of the observed lunar Mach cone provides the first experimental evidence for the anisotropic propagation of magneto-acoustic waves in the solar wind. The average Mach angle is found to be ~8° in directions perpendicular to the magnetic field vector and ~5.5° in the direction parallel to the field; this leads to a velocity anisotropy of $V_\perp/V_\parallel = 1.4$. This

value compares favorably with the nominal expected value in the solar wind of ~1.5, if $\beta = 1$ and $T_{||}/T_{\perp} = 1.2$. (auth)

7225 STATIONARY WAVES PRODUCED BY THE EARTH'S BOW SHOCK. Perez, J. K.; Northrop, T. G. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 6011-23 (1 Nov 1970).

Cyclotron waves should be produced upstream and downstream from the bow shock by current in the shock. Amplitudes and polarizations of waves produced by a steady thin current sheet in the plane of the shock were calculated by using cold plasma dispersion relations. The steady current leads to waves that are stationary in the shock frame. Waves upstream from the shock are circularly polarized electron waves, the polarization is in the sense of a right-hand screw when the interplanetary field is directed generally toward the shock, and of a left-hand screw when the field is directed away. The downstream magnetic wave field has two components, one from the electron cyclotron branch and one from the ion cyclotron branch of the dispersion relation. The second component has a longer wavelength and a larger amplitude (by the ion/electron mass ratio) than the electron wave. It is elliptically rather than circularly polarized and is always polarized in the opposite sense to the upstream electron wave. Therefore, the sense of polarization would be seen to reverse as the shock is traversed in either direction. When the ambient magnetic field is not perpendicular to the shock, there is also a stationary electrostatic wave with its electric field normal to the shock. Both upstream and downstream the ratio of the electrostatic wave to the magnetic wave amplitudes is of the order $u/c \tan \theta$, where θ is the angle between the normal to the shock and the magnetic field, and u is the plasma flow velocity. (auth)

7226 SPECTROMETER OBSERVATIONS IN THE REGION NEAR THE BOW SHOCK ON MARCH 12, 1968. Ossakow, S. L.; Sharp, G. W.; Harris, K. K. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Geophys. Res.; 75: 6024-36(1 Nov 1970).

Protons in the energy range 0 to 600 eV can be measured by the Lockheed light-ion spectrometer on Ogo 5 in the region of the bow shock. On March 12, 1968, directed fluxes some 3 orders of magnitude above the interplanetary level were detected in the magnetosheath on the inbound passage, orbit 3, from the solar wind through the magnetosheath and on the outbound passage, orbit 4, from the magnetosheath through the solar wind. Such sensitivity to the change in amplitude of the directed fluxes indicated seven shock crossings between 0043 and 0058 UT ($r = 14.75\ R_E$ to $r = 14.5\ R_E$) on the inbound pass and five shock crossings between 2042 and 2355 UT ($r = 17.15\ R_E$ to $r = 19.35\ R_E$) on the outbound pass. The enhanced proton fluxes correlate with the region where electrostatic wave turbulence becomes saturated as measured by the TRW experiment on Ogo 5 and with the sharp increases in magnetic field as measured by the UCLA magnetometer on the satellite. The protons, having traversed the microturbulence in the bow shock layer, are slowed and scattered with an attendant randomization of velocity vectors. The scale length L for scattering of the protons is $c/\omega_{pi} < L < 5\ c/\omega_{pi}$. This scale length is based on the time required for the scattering of protons into the wings of the velocity distribution and is not necessarily representative of the time required for heating of the proton component of the plasma. (auth)

7227 MAGNETIC-FIELD FLUCTUATIONS IN THE MAGNETOSHEATH OBSERVED BY PIONEERS 7 AND 8. Mariani, F. (Univ., Rome); Bavassano, B.; Ness, N. F. J. Geophys. Res.; 75: 6037-49(1 Nov 1970).

Fluctuations of the magnetic field at frequencies less than 0.05 Hz in the magnetosheath were studied from data obtained by Pioneers 7 and 8. During the first two weeks of their flights, the probes were in similar trajectories along approximately radial directions from the Earth to 250 R_E at an Earth–Sun-probe angle of 30°. Magnetic fluctuations inside the magnetosheath are transverse to the field vector; the largest fluctuations are perpendicular to the ecliptic plane. The entire spectrum is excited, the differential spectral power being proportional to $f^{-\alpha}$, where $1 < \alpha < 2$, there being no spectral lines at any particular frequency. The magnetic energy associated with the fluctuations is found to exponentially decay with increasing distance transverse to the Sun–Earth line. These results suggest that the fluctuations represent an enhanced microstructure produced by the amplification of small-amplitude fluctuations occurring at the bow shock, as McKenzie and Westphal proposed. (auth)

7228 MAGNETIC FIELD FLUCTUATIONS IN THE EARTH'S MAGNETOSHEATH. Fairfield, Donald H.; Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 6050-60(1 Nov 1970).

Imp 4 measurements were used to study magnetic field fluctuations in the sunward hemisphere of the magnetosheath. Power spectra were computed in the frequency range below 0.2 Hz in a field-aligned coordinate system which allows the separation of transverse and longitudinal perturbations. Power levels on different passes through the magnetosheath typically vary by an order of magnitude or more, and spectral peaks are frequently seen throughout the frequency range studied. Spatial variations of wave amplitudes are characterized by enhancements of the transverse mode near both the shock and the magnetopause, but these variations tend to be smaller than the day-to-day variations. The dawn quadrant of the magnetosheath tends to exhibit a somewhat higher level of fluctuations. Transverse waves are often linearly polarized and they tend to have their disturbance vector aligned with the shock and magnetopause surfaces. Compressional fluctuations tend to be larger than transverse fluctuations at low frequencies, but transverse amplitudes dominate at higher frequencies. On three unique orbits when the bow shock was located more than 9 R_E outside its average location the magnetosheath power levels were depressed by more than an order of magnitude below their normal lowest levels. Transverse fluctuations were dominant at these times. A weak positive correlation was found between magnetosheath fluctuations and geomagnetic activity. (auth)

7229 DIFFUSIVE ENTRY OF SOLAR-FLARE PARTICLES INTO GEOMAGNETIC TAIL. Michel, F. C. (Rice Univ., Houston, Tex.); Dessler, A. J. J. Geophys. Res.; 75: 6061-72(1 Nov 1970).

Solar-flare protons often enter the magnetospheric tail by a slow diffusion-like process. Solar-flare electrons, on the other hand, seem to enter rapidly, as would be consistent with either fast diffusion or direct entry along geomagnetic field lines that are connected to interplanetary field lines. The experimental results for both protons and electrons can be fit entirely to a diffusion model. The basic diffusion model utilizes a magnetospheric structure in which the tail is described as being composed of filaments, each having slightly different plasma and field properties. It is shown that it is possible to obtain energy-independent access of protons into such a tail model, at least over a broad range of proton energies. Diffusion results from the fluctuating fields seen by the protons in their cyclotron motion. This diffusion mechanism is ineffective for the electrons. The electrons enter further down the tail where the tail becomes flattened and the filaments intermingle with the interplanetary-field lines. Depending on the circumstances, the latter mechanism could be important for proton entry as well. Access to the distant tail regions should be sensitive to the direction of the interplanetary field relative to the tail field, that may account for the observed north-south polar-cap asymmetry. Merging of geomagnetic- and interplanetary-field lines could also become an important asymmetry mechanism when the size of the filaments becomes sufficiently small. (auth)

7230 KELVIN–HELMHOLTZ INSTABILITY AND THE SEMIANNUAL VARIATION OF GEOMAGNETIC ACTIVITY. Boller, Bruce R.; Stolov, Harold L. (City Coll., New York). J. Geophys. Res.; 75: 6073-84(1 Nov 1970).

Kelvin–Helmholtz instability along the flanks of the magnetosphere exhibits a semiannual variation, instability maximums occurring at the equinoxes and instability minimums at the solstices. It is suggested that Kelvin–Helmholtz instabilities, generated at the magnetopause, initiate the modulation of geomagnetic disturbance detected as the semiannual variation of geomagnetic activity. The Kelvin–Helmholtz explanation predicts a universal time variation of geomagnetic disturbance. This prediction is confirmed by several analyses of the geomagnetic activity indices. Since the physical mechanism suggested for the semiannual variation of geomagnetic activity depends on the tilt of the dipole axis, the equinoctial hypothesis is supported. (auth)

7231 ENERGETIC CARBON, NITROGEN, AND OXYGEN NUCLEI IN THE EARTH'S OUTER RADIATION ZONE. Van Allen, James A.; Randall, Bruce A.; Krimigis, Stamatios M. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 75: 6085-91 (1 Nov 1970).

During the period of relatively low geomagnetic-solar activity January 1 to 23, 1969, the presence of geomagnetically trapped nuclei $Z \geq 3$ of specific energies exceeding ≈ 0.3 MeV nucleon^{-1} is established in the outer radiation zone $L \gtrsim 2.0$. On the basis of general abundance considerations, these nuclei are identified presumptively as being the "medium weight" nuclei C, N, and O, with oxygen probably the most abundant. In the range $0.15 \leq B \leq 0.20$ gauss, the maximum intensity of C, N, and O nuclei occurs at $L \sim 3.2$. At this outer zone maximum, the sum of the absolute intensities of C, N, and O nuclei having specific energy ϵ_m exceeding ≈ 0.3 MeV nucleon^{-1} is 1.1 ± 0.2 (cm^2 sec ster)$^{-1}$ in a direction perpendicular to the local geomagnetic vector. In the ranges $3.0 \leq L \leq 3.5$, $0.15 \leq B \leq 0.20$, the ratio of the sum of the intensities of trapped medium weight nuclei C, N, and O to the inten-

sity of trapped α particles is $j_m/j_\alpha = (2.8 \pm 0.5) \times 10^{-3}$ above approximately the same specific energy $\epsilon_m = \epsilon_\alpha \approx 0.3$ MeV nucleon^{-1}. In the range $3.0 \leq L \leq 3.5$, the B dependence of the intensity of C, N, and O nuclei is similar to that of α particles. In the ranges $3.0 \leq L \leq 3.5$, $0.15 \leq B \leq 0.20$, differential energy spectrum of trapped α particles is $dj_\alpha/d\epsilon = 1.2 \times 10^5 \exp(-\epsilon/0.091)$ in units of (cm^2 sec ster MeV/nucleon)$^{-1}$, for $0.30 \leq \epsilon \leq 0.50$ MeV nucleon^{-1}. These results were obtained with a single-element, solid-state detector on the earth satellite Injun 5. (auth)

7232 PRELIMINARY RESULTS OF A LOW-ENERGY PARTICLE SURVEY AT SYNCHRONOUS ALTITUDE. Sharp, R. D. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.); Shelley, E. G.; Johnson, R. G.; Paschmann, G. J. Geophys. Res.; 75: 6092-6101(1 Nov 1970).

A preliminary analysis of the data from the first few weeks of operation of the Lockheed auroral particles experiment on ATS 5 revealed some interesting characteristics of the low-energy particle environment at synchronous altitude during magnetically quiet times. The most prominent feature of the data is the occurrence of enhanced electron fluxes during local night in association with magnetic bay activity as observed on ground magnetograms. A tentative description of some of the signatures of these magnetospheric substorm events is presented, based on the limited body of data that has currently been analyzed. The results of a preliminary statistical study of some of the electron plasma properties are compared with published data from a low-altitude polar satellite and with measurements made deep in the magnetospheric tail. The results are consistent with a model of magnetospheric convection in which auroral electrons are adiabatically compressed as they are convected inward and do not suggest the need for additional acceleration mechanisms to account for the average energization of the auroral electrons. (auth)

7233 OBSERVATIONS FROM OGO 5 OF THE THERMAL ION DENSITY AND TEMPERATURE WITHIN THE MAGNETOSPHERE. Serbu, G. P.; Maier, E. J. R. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 6102-13(1 Nov 1970).

The Ogo 5 retarding potential analyzer experiment is operated in a voltage mode designed to yield the integral spectrum of particles in the energy interval from 0 to 500 eV. Detailed results obtained with the spacecraft inside 7 R_E during the first 15 orbits (March–April 1968) are presented. Data are identified and grouped into three types of density profile. First is a smooth decrease in ion density from approximately 10^4 ions/cm^{-3} at 1.5 R_E down to the experiment threshold level of ~20 ions/cm^3 at approximately 5 to 6 R_E. A second general type of observed density profile is typified by considerable structure within the plasmasphere, and the plasmapause is identified by a factor of 3 or more drop in ion density. The third type of profile shows a density drop of a factor of 20 or more inside the L = 7 R_E radial distance to values below minimal detectable level of 20 cm^{-3}. The ion temperature observations show that within the plasmasphere the day-to-night temperature ratio is about a factor of 2, with the temperature ranging from a low of 5×10^3 °K at 1.5 R_E on the night side to as high as 3×10^4 °K at 3.6 R_E on the day side. At the plasmapause a sudden increase in the ion temperature is observed. This increase is generally a factor of 5 or more within 0.8 R_E, and it has been used to pinpoint the plasmapause location. Beyond the plasmapause, a region of relatively high ion temperature, $T_i > 10^5$ °K, is found. (auth)

7234 WHISTLER DUCT PROPERTIES DEDUCED FROM VLF OBSERVATIONS MADE WITH THE OGO 3 SATELLITE NEAR THE MAGNETIC EQUATOR. Angerami, Jacyntho J. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 6115-35(1 Nov 1970).

While the great majority of ground whistlers are interpreted as indirect evidence of magnetospheric ducts, the first direct evidence of ducts was obtained from the Stanford University broadband vlf experiments on Ogo 1 and Ogo 3. Five discrete whistler ducts were encountered by Ogo 3 on the inbound pass of June 15, 1966, between L = 4.7 and 4.1. Each duct was characterized by reception at the satellite of ducted whistlers with a distinct spectral shape, and of the high-frequency portions of whistlers (leakages) that propagated inward from outer ducts. The data were interpreted in detail by ray tracing in a model magnetosphere that includes ducts of enhanced ionization. The following conclusions resulted: (1) the L-shell thicknesses of the observed ducts ranged between 0.035 and 0.070 Earth radii, and the interduct separations ranged between 0.017 and 0.18 Earth radii; (2) the dimension of the ducts in longitude was estimated to be of the order of 4°, or 0.3 Earth radii at the equator, which is a factor of ~4 to 8 greater than the L-shell dimension; (3) the whistler ducts are much more likely to be enhancements than troughs; (4) the minimum enhancement factors needed to trap frequencies up to half the equatorial electron gyrofrequency are on the order of 8%, with smaller values producing upper cutoffs at lower frequencies; (5) the limited spreading of the calculated leaked rays is in general agreement with the corresponding regions of observation and relative signal amplitudes; (6) the low cutoffs of leaked signals are probably due to accessibility; (7) cyclotron and Landau interactions are likely to play a role in upper cutoffs of leaked signals; (8) the upper cutoff of ground whistlers near $f_{HC}/2$ is a trapping (rather than absorption) effect; (9) the hydrostatic-type of distribution of ionization along the field lines is applicable in the plasmasphere; and (10) the travel times (and frequency of minimum delay) of ducted whistlers can be calculated with good accuracy by assuming purely longitudinal propagation. (auth)

7235 VLF ELECTRIC FIELD OBSERVATIONS IN THE MAGNETOSPHERE. Kennel, C. F.; Scarf, F. L.; Fredricks, R. W.; McGehee, J. H.; Coroniti, F. V. (TRW Systems Group, Redondo Beach, Calif.). J. Geophys. Res.; 75: 6136-52(1 Nov 1970).

New types of magnetospheric electric field emissions were detected by Ogo 5 with wave frequencies (f) above the local electron cyclotron frequency (fc). The most common emissions occur between the lowest electron cyclotron harmonics ($f \approx 3fc/2$), followed by emissions at high frequencies ($f \gg fc$). A few signals were observed slightly above the local fc. The strong emissions with $f > 3fc/2$ appear to be localized within a few degrees of the geomagnetic equator. More than 60% of the equator crossings between $4 < L < 10$ in the 0000–1200 LT sector have such activity. The waves have large electric field amplitudes (1 to 10 mV/m), which suggest they may be sources of pitch-angle diffusion and turbulent energization of auroral-zone electrons. (auth)

7236 VERY-LOW-FREQUENCY AND PARTICLE ROCKET EXPERIMENT AT KERGUELEN ISLANDS. I. VERY-LOW-FREQUENCY MEASUREMENTS. Gendrin, R.; Berthomier, C.; Cory, H.; (and others) (Groupe de Recherches Ionospheriques, Saint-Maur, France). J. Geophys. Res.; 75: 6153-68(1 Nov 1970).

Three rockets were launched along the magnetic field lines, up to an altitude of ~400 km, to study the wave–particle interactions that take place during natural vlf emissions. The group-delay time was measured for the structured elements of dawn chorus, using a correlation technique. This time is shown to be in good agreement in the ascending part of the flight with the theoretical one deduced from the Appleton–Hartree formula with the use of simultaneous ionospheric soundings giving the electron density above the station. Changes at the end of the flight show discontinuities in the electron density profiles and set an upper limit to the area on which vlf signals detected on the ground are coherent. From the intensity measurements, comparison is made with the theory of attenuation and reflection of vlf waves ($f < 2$ kHz) when passing through the ionosphere. A general agreement was found between the theoretical and experimental results, as far as the shape of the amplitude variation as a function of height is considered. Large discrepancies in the absolute values are observed that are attributed to oblique incidence of the waves. Polarization measurements permit a circular polarization to be ascribed to these waves even at vlf, except in the lower ionosphere ($h < 120$ km) where it shows a tendency to become elliptical. (auth)

7237 VERY-LOW-FREQUENCY AND PARTICLE ROCKET EXPERIMENT AT KERGUELEN ISLANDS. 2. PARTICLE MEASUREMENTS. Gendrin, R.; Etcheto, J.; de la Porte des Vaux, B. (Groupe de Recherches Ionospheriques, Saint-Maur, France). J. Geophys. Res.; 75: 6169-81(1 Nov 1970).

The mean particle-distribution functions observed between 100 and 400 km at L ~ 3.7 are in agreement with other measurements made in the same energy range and at the same L value; these measurements extend the results toward lower energies and lower altitudes. The proton energy distribution is fitted by two experimental curves with e-folding energies $E_0 \sim 50$ keV up to energies of the order of 400 keV and $E_0 \sim 1$ MeV above. The same is generally true for the electron distribution, although the break in the spectrum is less marked, the e-folding energies being $E_0 \sim 20$ keV up to 100 keV and $E_0 \sim 100$ keV above. The ratio $J_\perp/J_\parallel$ is usually smaller for protons than for electrons, especially for one flight during which it was smaller than 1. Some characteristics of the particle fluxes have been observed in relation to vlf emissions: a flux increase of the newly injected electrons, both trapped and precipitated, is observed during dawn chorus events. A highly characteristic fluctuation (T ~ 80 sec) of the trapped electron intensities has been detected in coincidence with a vlf periodic hiss emission and a hydromagnetic wave of the same periodicity. This phenomenon is interpreted in the frame of reference of the quasi-linear theory as a pitch-angle scattering associated with vlf emission. (auth)

7238 RAPID AURORAL LUMINOSITY FLUCTUATIONS AND GEOMAGNETIC FIELD PULSATIONS. Campbell, W. H.

(ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 75: 6182-6208(1 Nov 1970).

The relationship of 4278-A emission fluctuations and rapid geomagnetic field variations during two active disturbance periods at Byrd, Antarctica, was studied in detail. These quasi-sinusoidal pulsation data were compared with the simultaneous field changes at the conjugate location of Great Whale River, Canada. Common spectral characteristics of the light and field were examined. A five-phototube array was used to identify large-scale auroral pulsation events and to separate them for analysis of stationary and moving forms. For the stationary group of pulsations, the geomagnetic field changes occur about 1.3 sec later than the auroral luminosity. This delay increases with increasing E-region electron density. It is reasoned that quasi-trapped electron bouncing is not important in determining the pulsation periodicity and that the luminosity is an indicator of the ionospheric arrival of a hydromagnetic wave, which is there converted to an electromagnetic disturbance. Travel time for an electromagnetic pulse through a conducting medium is computed and is shown to be consistent with the observed delays. (auth)

7239 VACUUM ULTRAVIOLET EMISSION FROM AURORAS. Peek, H. Milton (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res.; 75: 6209-17(1 Nov 1970).

Quantitative measurements of vacuum ultraviolet spectra and 3914-A emission from auroras were made over a 105- to 315-km altitude range by using Nitehawk rockets launched at Fort Churchill, Manitoba. These data and results of other investigators show that the ratio of volume emission rates for the Lyman–Birge–Hopfield system and 3914-A N_2^+ varies from 1:3 to 2:1 for different auroras. The strongest vacuum ultraviolet signal was from the 1304-A O I resonance line; the next strongest was the 1200-A N I resonance line. Hydrogen Lyman-α emission at 1216 A, although slightly stronger than 1200-A N I, did not originate in the aurora. Maximum overhead intensities and corresponding altitudes were tabulated. The 1304-A O I and 1200-A N I radiations are believed to be excited by electron impact on the atoms. (auth)

7240 DEPRESSIONS IN THE FAR-ULTRAVIOLET AIRGLOW OVER THE POLES. Meier, R. R. (Naval Research Lab., Washington, D. C.). J. Geophys. Res.; 75: 6218-32(1 Nov 1970).

Observations of the ultraviolet emissions of atomic hydrogen (Lyman α) and atomic oxygen (1304-A) over the polar regions from the Ogo 4 satellite show that the airglows are sometimes depressed to the nonpolar levels. The Lyman α decreases are a manifestation of a reduction in the polar hydrogen concentration, apparently associated with the region of open magnetic field lines. The polar hydrogen concentration is estimated to be approximately 37% below the nonpolar level for a Lyman α depression of 10%, and 27% below the nonpolar level for a 5% depression. The 1304-A decreases are apparently related to a change in the exciting photoelectron concentration, when either the field lines are open or the conjugate ionosphere is in shadow. (auth)

7241 EQUATORIAL AURORA/AIRGLOW IN THE FAR ULTRAVIOLET. Hicks, G. T.; Chubb, T. A. (Naval Research Lab., Washington, D. C.). J. Geophys. Res.; 75: 6233-48(1 Nov 1970).

Far-ultraviolet emissions in the equatorial zone were detected at altitudes of less than 500 km with an experiment aboard the Ogo 4 polar-orbiting satellite. The occurrence frequency reached a maximum in both late October and early March during the period August 1967 to May 1968. Both maximums occurred near 2130 local time. Low values during June 1968 indicate a strong seasonal dependence. The emissions were seen quite symmetrically in position at 12 to 15° on either side of the magnetic dip equator completely encircling the earth. Often, the peak intensity of the emissions was the same north and south of the equator, but in some cases the intensity was three or four times greater on one side than on the other. In rare cases, emission was totally lacking on one side while clearly present on the other. Simultaneous comparisons of quick-look scanning spectrometer data of Barth from Ogo 4 show that the emissions are oxygen lines at 1304- and 1356-A. Possible mechanisms for production of these emissions are discussed. (auth)

7242 VERTICAL DRIFT VELOCITIES AND EAST–WEST ELECTRIC FIELDS AT THE MAGNETIC EQUATOR. Woodman, Ronald F. (Instituto Geofisico del Peru, Lima). J. Geophys. Res.; 75: 6249-59(1 Nov 1970).

Incoherent scatter observations of vertical drifts taken at Jicamarca (2° dip) are presented. Vertical drifts are found to be nearly constant as a function of height. These vertical drifts can also be taken as a direct measurement of the east–west electric fields at the magnetic equator. Their daily and seasonal behavior is presented. The effect of geomagnetic activity is discussed. (auth)

7243 PHOTOELECTRON FLUXES IN THE IONOSPHERE. Nagy, A. F.; Banks, P. M. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 75: 6260-70(1 Nov 1970).

Calculations were made of photoelectron fluxes and energy spectra in the ionosphere for pre-dawn and sunlit atmospheres, taking account of transport, elastic and inelastic collisions, and energy loss to ambient electrons. For pre-dawn models the results indicate that a significant fraction of the incoming electrons are backscattered. By using recent pre-dawn measurements of the high-altitude incident electron flux, the rates of O I (6300 A) emission and secondary ionization rates are computed. An escape flux of the order of 4.1×10^8 electrons cm^{-2} sec^{-1} is calculated for the sunlit atmosphere. The present results are compared with recent rocket measurements and previous calculations. The problem of a recently noted reduction in O I (1304 A) emissions in polar regions is also discussed. (auth)

7244 SEASONAL VARIATION OF THE O/N_2 RATIO IN THE F1 REGION. Cox, L. P.; Evans, J. V. (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res.; 75: 6271-86(1 Nov 1970).

Incoherent scatter measurements of the altitude variation of the ratio of atomic ions (O^+) to electrons are presented that supplement earlier ion composition measurements made in the region 130 to 240 km at the Millstone Hill radar. An improved technique is used for recovering the ratio $\rho = [O^+]/N_e$ from the observations. No assumptions need be made about the electron temperature, and the allowance for the variation of the measured parameters within the height interval occupied by the exploring pulse is made. As in earlier measurements at Millstone Hill, a definite seasonal variation in ρ was found with O^+, extending to lower altitudes in winter than in summer. These ratios are used, together with measurements of the electron density and relevant theory, to derive the corresponding seasonal variation in the ratio of O to N_2. Finally, the seasonal variation in O/N_2 obtained here is compared with measurements of O/N_2 made by rocket- and satellite-borne mass spectrometers. (auth)

7245 GROWTH AND STABILITY OF ARTIFICIAL ION CLOUDS IN THE IONOSPHERE. Simon, Albert (Univ. of Rochester, N. Y.). J. Geophys. Res.; 75: 6287-94(1 Nov 1970).

A number of instabilities that may account for sudden onset of striations in ionospheric barium clouds are considered. The E × B instability, driven by confined action of the ambient ionospheric electric field and the cloud density gradient, is shown to be the most likely cause. The equilibrium state of the cloud is obtained by an expansion technique, yielding ion density, internal electric field, and cloud velocity. The linearized small oscillation equations are then obtained and are reduced to two-dimensional form. A trial solution yields an instability threshold (expressed either as critical electric field or as onset time delay) that is of reasonable magnitude. (auth)

7246 WAVE-INDUCED FLUCTUATIONS IN IONOSPHERIC ELECTRON CONTENT: A MODEL INDICATING SOME OBSERVATIONAL BIASES. Georges, T. M.; Hooke, W. H. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 75: 6295-6308 (1 Nov 1970).

By assuming that a plane atmospheric wave acts on a plane-stratified F layer in the presence of a constant geomagnetic field, an expression is derived for the resulting perturbations in total-columnar electron content as a function of wave and ionospheric-layer parameters and of the orientation of the column through the ionosphere. Although idealized, the model not only correctly predicts the order of magnitude of the observed perturbations but also makes visible much of the physics that determines the magnitude of wave-induced total-content fluctuations observed by using satellite transmissions through the ionosphere. Geomagnetic constraints on ion motion and a tendency for total-content fluctuation to be greatest when the ground-satellite path lies in a surface of constant atmospheric wave phase combine to introduce strong experimental biases that favor the observation of some waves and prevent the observation of others. The effects of these biases must be fully removed before total-content measurements can yield the statistical properties of atmospheric waves at ionospheric heights that may be useful in locating wave sources or in characterizing the dynamic state of the ionosphere. (auth)

7247 EXPLICIT SOLUTION FOR POLYTROPE SOLAR WIND EQUATIONS. Yeh, Tyan (New York Univ., N. Y.). J. Geophys. Res.; 75: 6309-11(1 Nov 1970).

An explicit solution for polytrope solar winds is presented in which both the distance and the flow velocity are expressed as simple functions of the mass density. The correspondence between the velocity and the distance is explicitly exhibited through the intermediary parameter, the mass density. Thus, numerical solutions for polytrope solar winds can be generated by evaluation of simple algebraic functions. (auth)

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7248 VISCOUS MODEL OF SOLAR WIND FLOW. Dahlberg, E. (European Space Research Inst., Frascati, Italy). J. Geophys. Res.: 75: 6312-17(1 Nov 1970).

The viscous model of the solar wind formulated by Whang et al. is examined. The results are qualitatively and quantitatively different from those published earlier. The reasons for the quantitative discrepancies were found, so that by deliberately introducing certain specified errors, the earlier results could be reproduced. Qualitatively, a new two-parameter family of asymptotic solutions is found in addition to the one-parameter family for which the earlier computations were made. The special computational difficulties inherent in the problem are discussed. (auth)

7249 DEVELOPMENT OF A POLAR MAGNETIC SUBSTORM CURRENT SYSTEM. Rostoker, G. (Univ. of Alberta, Edmonton); Anderson III, C. W.; Oldenburg, D. W.; (and others). J. Geophys. Res.: 75: 6318-23(1 Nov 1970).

Evidence is presented illustrating the westward motion of the magnetic perturbation pattern of polar magnetic substorms during the course of these events. This motion is related to the lengthening of the ionospheric part of the substorm current system and the motion of the westward-traveling surge. (auth)

7250 PARTICLE ACCELERATION BY ELECTROSTATIC WAVES. Swift, Daniel W. (Univ. of Alaska, College). J. Geophys. Res.: 75: 6324-8(1 Nov 1970).

The work of Gary, Montgomery, and Swift (1968) is extended to show that a coherent electrostatic wave whose wave number is a slowly varying function of position will produce a nearly monoenergetic beam of particles. The effect is demonstrated by numerical examples and by analysis of a phase plane diagram. Numerical calculations for the motion of a particle in a wave whose phase is interrupted at regular intervals indicate that an incoherent wave can produce a burst of particles with a broad energy spectrum. (auth)

7251 COMPRESSIBLE COROTATION OF A MODEL MAGNETOSPHERE. Schulz, Michael (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.: 75: 6329-32(1 Nov 1970).

Calculated for a simplified model of the distorted magnetosphere, the electric field induced by the Earth's rotation exhibits an azimuthal asymmetry somewhat similar to that of the magnetic field. Analytical tracing of the resultant field-line motion in the equatorial plane indicates that the magnetosphere does not rotate rigidly with the Earth, although the time (one day) required for a complete rotation is the same for all field lines, as is expected. The calculated analytical representation of the rotation-induced electric field, or some generalization thereof, may be of value in studying the flow of cold plasma in a model magnetosphere. (auth)

7252 PHOTOIONIZATION COEFFICIENTS AND PHOTOELECTRON IMPACT EXCITATION EFFICIENCIES IN THE DAYTIME IONOSPHERE. Stewart, A. I. (Univ. of Colorado, Boulder). J. Geophys. Res.: 75: 6333-8(1 Nov 1970).

Photoelectron impact is an important or dominant excitation process for several dayglow emissions. Calculations show empirically that, to a sufficient approximation, both the photoionization coefficients of atmospheric gases and the photoelectron excitation efficiencies for high-lying states can be represented as simple functions of an effective total slant-column density of the neutral gases in the solar direction, a small correction for the local electron/neutral density ratio being necessary for the excitation efficiencies. The prediction, in any given model atmosphere, of photoionization rates and of the intensities of the Lyman–Birge–Hopfield and second positive bands of molecular nitrogen and the 1356-A line of atomic oxygen, and of the photoelectron impact contribution to the excitation of the 1304-A resonance triplet of atomic oxygen, is thereby rendered trivial. (auth)

7253 NONUNIQUENESS OF THE EXTERNAL GEOMAGNETIC FIELD DETERMINED BY SURFACE INTENSITY MEASUREMENTS. Backus, George E. (Univ. of California, San Diego). J. Geophys. Res.: 75: 6339-41(1 Nov 1970).

For N = 3, an example is given of two functions u and v that are harmonic outside a solid sphere V in real N space, that vanish at infinity, that satisfy $|\nabla u| = |\nabla v|$ everywhere on ∂V, the surface of V, and for which neither u + v nor u − v vanishes identically outside V. It follows that the external magnetic field in B produced by currents within a solid sphere V need not be determined up to sign by complete knowledge of the intensity |B| as a function of position on ∂V. (auth)

7254 WORLD CONTOURS OF CONJUGATE MIRROR LOCATIONS. Barish, Franklin D. (Univ. of Denver); Wiley, Robert E. J. Geophys. Res.: 75: 6342-6(1 Nov 1970).

The technique for calculating mirror point location employs the Invar computer package with slight modifications and the GSFC (12/66) field coefficients, i. e., a field model (Cain et al., 1967) consisting of 120 coefficients and their time derivatives. The present calculations were made by using a 3° × 3° mesh in latitude and longitude, extending from 87°S to 87°N, and from 0° to 360°E. Several values of conjugate latitude and longitude as read from the map by Campbell and Matsushita were compared with the mirror point location as read from the maps presented in the paper. Contours of mirror point locations complement the Campbell and Matsushita calculations with information useful in studies associated with photoelectron injection, and auroral backscatter, and artificial source injection. (J.C.W.)

7255 MEASUREMENT OF THE DISTRIBUTION IN ENERGY AND ANGLE OF HIGH-ENERGY ALBEDO NEUTRONS AND DETERMINATION OF AN UPPER LIMIT FOR THE SOLAR NEUTRON FLUX. Heidbreder, E.; Pinkau, K.; Reppin, C.; Schoenfelder, V. (Max-Planck-Institut fuer Physik and Astrophysik, Garching, Ger. Institut fuer Extraterrestrische Physik, Garching, Ger.). J. Geophys. Res.: 75: 6347-9(1 Nov 1970).

A balloon was launched at Palestine, Texas, on Sept. 15, 1969 to determine the angular distribution and energy spectrum of the flux at the float altitude of 7 g/cm^2. Of 130 events, 17 were elastic neutron–proton collisions, the others being mainly inelastic interactions with the carbon of the scattering material. Differentiation between elastic and inelastic events is based on the requirement that the angle between the neutron's path of flight after the scattering event and the proton has a value close to 90°. From the kinematics of the two scattering events, the energy and angle of incidence of each neutron were determined. The upper limit for the solar neutron flux at the top of the atmosphere in the energy range 100 to 400 MeV resulting from our measurements is 1.25×10^{-3}/cm^2 sec. New sophisticated equipment is being developed to improve the measurements. (J.C.W.)

7256 SOLAR WIND IONS: $^{56}Fe^{+8}$ TO $^{56}Fe^{+12}$, $^{28}Si^{+7}$, $^{28}Si^{+8}$, $^{28}Si^{+9}$, AND $^{16}O^{+6}$. Bame, S. J.; Asbridge, J. R.; Hundhausen, A. J.; Montgomery, Michael D. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res.: 75: 6360-5(1 Nov 1970).

Ion species of ^{56}Fe are unambiguously resolved in the near-Earth solar wind of July 6, 1969, using an electrostatic heavy ion analyzer on the Vela 5A satellite. Five separate groups are identified as $^{56}Fe^{+8}$ to $^{56}Fe^{+12}$ and their relative abundance suggests that the ion state was "frozen in" over a narrow range of heliocentric distance and coronal temperature. The mean temperature inferred depends on the choice of ionization state calculations that give about 1.5×10^6 °K in one case and 1.26×10^6 °K in another. Other resolved groups can be identified as $^{28}Si^{+7}$, $^{28}Si^{+8}$, and $^{28}Si^{+9}$ but may contain small amounts of nearby sulfur ions. The $^{16}O^{+6}$ species, previously identified in the solar wind with Vela 3 measurements, is also well resolved in the Vela 5A data. The relative abundances of oxygen, silicon, and iron ions at this time were 1.00, 0.21, and 0.17, remarkably similar to the coronal abundances reported by Pottasch and unlike the solar system, photospheric, and solar cosmic ray abundances. (auth)

7257 INTERPLANETARY SECTOR STRUCTURE NEAR THE MAXIMUM OF THE SUNSPOT CYCLE. Wilcox, John M. (Univ. of California, Berkeley); Colburn, David S. J. Geophys. Res.: 75: 6366-70(1 Nov 1970).

The interplanetary magnetic sector structure during 1968 was investigated. During most of the year there were two sectors per solar rotation. The sector structure remains well established despite the increased solar activity near sunspot maximum. The rotation period of the interplanetary field was 27.0 ± 0.1 days. (auth)

7258 MASS SPECTROMETER OBSERVATION OF NO IN AN AURORAL ARC. Zipf, E. C.; Borst, W. L.; Donahue, T. M. (Univ. of Pittsburgh). J. Geophys. Res.: 75: 6371-6(1 Nov 1970).

On March 25, 1970 at 0445 UT, an Aerobee rocket was launched into a bright IBC 2$^+$ auroral arc above Fort Churchill, Manitoba. Instrumentation included a quadrupole mass spectrometer, separate primary and secondary electron-energy analyzers, a cylindrical electron probe, and a planar total positive ion probe. The neutral and ion data obtained by the mass spectrometer are discussed. Remarkably large concentrations of NO and NO^+ were observed within the auroral form. The molecular ions O_2^+ and N_2^+ were conspicuously absent and comparatively large densities of O^+ ions were detected. In the altitude range 110 to 130 km the neutral NO concentration exceeded the ambient O_2 concentration. (J.C.W.)

7259 SUBSIDIARY RESONANCES IN THE IONOSPHERE. Chen, C. S. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.: 75: 6377-81(1 Nov 1970).

A prolonged ringing at the receiver of a topside sounder satellite after the transmitter has been turned off is a manifestation of ionospheric resonance. Subsidiary resonances are fractional ringing of the principal resonant frequencies, such as plasma frequency, cyclotron frequency, and upper hybrid frequency. References are cited for the identification of possible resonant frequencies, but no time-decay behavior of the related responses can be obtained. An improvement is presented of the source model to a 2-grid finite pulse rather than the continuous source model to study the time-decay behavior of the response at resonances. A uniform infinite electron plasma driven by an infinitestimally separated 2-grid finite pulse source is considered. It is shown analytically that principal resonances may occur in higher orders when driven at a fraction of the principal resonant frequencies. Known observations are explained if transmission and reception occur in the region of the ionosphere such that a pair of principal resonant frequencies can be excited in successive order simultaneously and an observable signal is obtained through the beat between them. (J.C.W.)

7260 DOPPLER SHIFT IN HIGH-FREQUENCY GROUND BACKSCATTER COMPARED WITH DOPPLER SHIFT IN A RETRANSMITTED SIGNAL. Dearden, E. W. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 6382-6(1 Nov 1970).

An experiment is described that indicates for a high-frequency radio signal traveling a one-hop forward and return path, the changing ionosphere imposes a Doppler shift that is the same, regardless of whether the signal is returned by ground backscatter or is retransmitted from a fixed location. Pulse transmissions at 23.100 MHz were made from Stanford on a single east-looking rhombic antenna. The operating frequency was chosen so that ground backscatter was obtained from a region including a Stanford field site at Bearden, Arkansas. At this location a repeater received, amplified, and reradiated the signal toward another Stanford field site at Los Banos. The signals were received with a highly directive wide-band HF array. The receiving system had a 6-kHz bandwidth with all frequencies referenced to a primary standard. It is concluded that the Doppler shift theory is not appropriate to hf ground backscatter. If the Doppler shift of ground backscatter is observed through a range gate and the ionosphere is changing, the contributing scattering region moves over the ground. (J.C.W.)

7261 STRUCTURE OF PARTIALLY REFLECTING REGIONS IN THE LOWER IONOSPHERE. Gregory, J. B.; Vincent, R. A. (Univ. of Saskatchewan, Saskatoon). J. Geophys. Res.; 75: 6387-9(1 Nov 1970).

Results are discussed from various experiments that are relevant for using partially reflected medium-frequency radio waves for determination of electron densities. Two models of the reflection process are presented that are proposed for use in connection with differential absorption measurements. One model assumes that reflection occurs at a single irregularity of horizontal extent sufficient to fill a Fresnel zone. The other model assumes that scattering occurs throughout a volume in which irregularities are continuously distributed. An analysis was made of many observations of heights and strengths of partial reflections at 1.75 MHz, taken at 44°S (Christchurch, New Zealand) from 1955 to 1964. One pattern predominated and can be interpreted as corresponding to an altitude interval in which reflected power, averaged over several minutes, increases roughly exponentially with altitude. The form of the distributions are interpreted as indicating that on many occasions reflections were confined within an altitude interval of less than 1 km, i.e., less than the height resolution of the equipment. (J.C.W.)

7262 LARGE FLUXES OF 1-keV ATOMIC HYDROGEN AT 800 KM. Wax, R. L.; Simpson, W. R.; Bernstein, W. (TRW Systems Group, Redondo Beach, Calif.). J. Geophys. Res.; 75: 6390-3(1 Nov 1970).

Energetic neutral hydrogen fluxes in the range 10^9 to 10^{10} cm^{-2} sec^{-1} appear to have been detected during a rocket flight on March 7, 1970, to 840 km. Although the rocket entered a region of only 80% totality, eclipse conditions were desirable, solar uv and other sources of background counts made no significant contributions to the observed atomic hydrogen and proton fluxes. A single hemispherical electrostatic analyzer had three separate entrance apertures and channeltron detectors to provide simultaneous measurements of neutral hydrogen, protons, and background. Two complete instruments were mounted back to back to give complete redundance in the measurements. The average flux of energetic hydrogen atoms was 5×10^9 atoms cm^{-2} sec^{-1} $ster^{-1}$ keV^{-1} at 1 keV. It is believed that the results are valid because 1) the background channel counting rates were a factor of 10^2 less than those observed in the H^+ channel, so, spurious counts caused by high-voltage breakdown, solar uv, high-energy radiation, and ionospheric effects were not important; 2) the H^+ fluxes and energy spectra derived from the instruments were consistent although foils were of different thicknesses and had significantly different efficiency factors; and 3) the source location was identical for both instruments although they viewed the region at different times in the spin cycle. (J.C.W.)

7263 OBSERVATION OF SLOW SHOCKS IN INTERPLANETARY SPACE. Chao, Jih Kwin; Olbert, Stanislaw (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res.; 75: 6394-7 (1 Nov 1970).

Two events believed to be slow-mode MHD shocks were analyzed from data collected during the Mariner 5 flight to Venus, June 14, 1967. Bulk velocity, number density, and thermal speed of the solar wind protons were measured by a Faraday cup. An analysis of these data showed the first event occurred on July 20, 1967 at 3.5×10^6 km from the Earth, and the second, Aug. 30, 1967 at 2.7×10^7 km from the Earth. The method used to identify these shocks is outlined and it is shown that the two events satisfy the criteria for slow-mode shocks. (J.C.W.)

7264 IONOSPHERIC MODIFICATION EXPERIMENT USING VERY HIGH POWER, HIGH FREQUENCY TRANSMISSION. Utlaut, W. F. (Inst. for Telecommunication Sciences, Boulder, Colo.). J. Geophys. Res.; 75: 6402-5(1 Nov 1970).

An experiment resulting in ionospheric modification of the F region through heating by an hf-transmitting facility located near Boulder, Colorado, has begun. This facility has a transmitter capable of producing nearly 2 MW of average power, which, when used in conjunction with a 10-element ring-array antenna, results in a power-aperture product of the order of 10^4 MW m^2. Salient effects observed with radio-wave measurements after the heating transmitter had been turned on are: a prompt ionospheric response appearing within 30 sec as a deformation in the traces on ionosonde records; a development and growth of spread F starting within tens of seconds, frequently followed by multiple splitting of the O and X traces; appearance of a new time-varying broadband echo which, at times, occurs after 10 min or more of heating and which changes in range with time; and a decrease, within 10 sec, of about 10 db in the amplitude of the O component alone, measured on an oblique path when heating with the O wave. Photometric measurements of 6300-A airglow from the heated region indicate about a 30% rise in electron temperature. Infrared radiation at 1.27 μ is enhanced in a region located down the magnetic field lines traversing the higher region initially heated by the radio wave. (auth)

7265 HEATING THE F REGION BY DEVIATIVE ABSORPTION OF RADIO WAVES. Meltz, G. (Mitre Corp., Bedford, Mass.); LeLevier, R. E. J. Geophys. Res.; 75: 6406-16(1 Nov 1970).

The heating and hydrodynamic expansion of the F region caused by absorption of an incident radio wave occurs in several phases. The theoretical model is restricted to the early phase, i. e., to the initial stages of heating when electron density changes are small and the electron and ion temperatures are approaching or have reached steady state. The numerical results are based on the neutral composition assumed to be given by Cira 1965, model 5, at 2000 hours, and the nighttime F-layer electron density is taken to be an α Chapman layer with the scale height H = 40 km, peak height = 310 km, and the maximum plasma frequency = 7.0 MHz. A comparison of the predicted results and the observed ionogram changes, airglow modulations, infrared emission, and short-pulse measurements is not possible at this time. (J.C.W.)

7266 SOME F-REGION PARAMETERS MEASURABLE IN THE BOULDER HEATING EXPERIMENT. Whitehead, J. D. (Inst. for Telecommunication Sciences, Boulder, Colo.). J. Geophys. Res.; 75: 6417-18(1 Nov 1970).

The effect of heating by a powerful radio wave reflected from the F region of the ionosphere is considered. Calculations are presented for heating performed by a reflected radio wave injecting heat into a thin slab near the reflection height when the D- and E-region nondeviative absorption is ignored. (J.C.W.)

7267 ARTIFICIAL HEATING OF THE IONOSPHERE: EARLY TIME PHENOMENA. LeLevier, R. E. (Rand Corp., Santa Monica, Calif.). J. Geophys. Res.; 75: 6419-20(1 Nov 1970).

A mechanism is discussed that operates to increase electron densities at early times, long before substantial hydrodynamic expansion can occur in the ionosphere. The mechanism derives from the temperature-dependence of the recombination chemistry of the F region. Generally, dissociative recombination of electrons with the molecular ions O_2^+ and NO^+ are the main processes governing the disappearance of electrons in the lower F region. On the other hand, the formation of these molecular ions depends on reactions of O^+ with the molecules of nitrogen and oxygen.

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The ion of atomic oxygen O^+ is the dominant ion above altitudes of about 230 km in the nighttime ionosphere. The dissociative recombination coefficient of electrons with molecular ions decreases with increasing electron temperature. Percentage increase in electron density due to heating as a function of time is tabulated at 220, 230, and 240 km. Changes in electron densities at higher altitudes are clearly dependent on the competition between electron temperature elevations that increase with increasing temperature up to 300 km and the decrease in the relative concentration of molecular ions with increasing altitude. (J.C.W.)

7268 OPTICAL (λ6300) DETECTION OF RADIO FREQUENCY HEATING OF ELECTRONS IN THE F REGION. Biondi, A. A.; Sipler, D. P.; Hake, R. D. Jr. (Univ. of Pittsburgh). J. Geophys. Res.; 75: 6421-4(1 Nov 1970).

Detection of significant (~30%) changes in the electron temperature in the F2 layer produced by absorption of radio-frequency energy propagated at or near the local ionospheric plasma frequency is described. The radio-frequency source is a 1-MW cw transmitter and ~16° beamwidth antenna array. The electron heating detection method is through the attendant effect on the rate of electron-O_2^+ ion dissociative recombination and hence on the O $I(^1D \rightarrow {}^3P)$ 6300-A radiation intensity. At 250 to 300 km, O_2^+ is a minority ion. It is concluded that an observable effect in λ6300 nightglow intensity has been noted that correlates with heating of electrons in the F region by means of a powerful ground-based transmitter tuned to plasma resonance at an electron density somewhat below the F2 peak value. The form of the λ6300 intensity modulation induced by the turning on and off of the transmitter is consistent with a model of λ6300 emission resulting from dissociative recombination of electrons and O_2^+ ions, the rate of which is inversely related to the electron temperature. (J.C.W.)

7269 PRELIMINARY RESULTS FROM THE 1.27-MICRON MEASUREMENTS IN THE BOULDER IONOSPHERIC MODIFICATION EXPERIMENT. Evans, W. F. J. (Univ. of Saskatchewan, Saskatoon); Llewellyn, E. J.; Haslett, J. C.; Megill, L. R. J. Geophys. Res.; 75: 6425-8(1 Nov 1970).

Assuming that the excitation during during aurorae is due to heated ambient electrons, observations of 1.27-μ radiation were performed during the operation of the transmitter during the Boulder experiment. The observations were made with a high-sensitivity two-channel infrared photometer that employs thermoelectrically cooled PbS detectors. It appears that the 1.27-μ radiation was altered by the operation of the transmitter, but details of the mechanism by which the $O_2(^1\Delta_g)$ is excited are questionable. The 6300-A observations indicate a 30% change of the electron temperature. The enhanced temperature can be present throughout the flux in which the energy is deposited, with the energy being carried by the electrons through thermal conduction. Some process appears to be exciting the $O_2(^1\Delta_g)$ state both in this heating experiment and in the aurora. There is a possibility that some other unknown emission might be present in the 1.27-μ wavelength region detected by the photometer. (J.C.W.)

7270 SOME IONOSONDE OBSERVATIONS OF IONOSPHERE MODIFICATION BY VERY HIGH POWER, HIGH FREQUENCY GROUND-BASED TRANSMISSION. Utlaut, W. F.; Violette, E. J.; Paul, A. K. (Inst. for Telecommunication Sciences, Boulder, Colo.). J. Geophys. Res.; 75: 6429-35(1 Nov 1970).

Significant ionospheric modification resulting from F-region heating-power, high-frequency transmitter located near Boulder, Colorado, is discussed. A description of the Platteville heating transmitter facility, the locations of ionosonde and photometric diagnostic equipment, and the geometry of the experiment are given in a paper by Utlaut. A single-plane inverted log periodic antenna, which has a half-power beam-width of the order of 90°, was used for transmitting. The heating transmitter antenna was connected to provide extraordinary wave illumination during the periods in which the ionograms were made. Salient effects observed in the ionosonde records following the turn-on of the high-power transmitter are a prompt ionospheric response appearing within 30 sec and a deformation in both O and X traces at the virtual height at which the extraordinary component of the frequency used for heating was reflected; a development and growth of spread F, starting within tens of seconds, frequently followed by distinct structure in both magnetoionic echo traces; a time-varying broad-band oblique incidence echo which, at times, develops after 10 min or more of heating and which also changes in range with time; and variation in the strength of signals returned from the ionosphere. (J.C.W.)

7271 AMPLIFICATION OF IONOSPHERIC HEATING AND TRIGGERING OF SPREAD F BY NATURAL IRREGULARITIES. Georges, T. M. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 75: 6436-8(1 Nov 1970).

The role of natural irregularities in getting the heating started in the ionosphere, thereby triggering spread F, is considered. Many natural ionospheric irregularities are capable of focusing radio energy into very small volumes. With such irregularities present, a megawatt transmitter might be expected to produce a quasi-random distribution of small, intensely heated regions in the ionosphere. Computation of ray paths through several model ionospheric irregularities was made with a view toward examining the self-amplification mechanism as well as the group-delay spread of rays received by a simulated ionosonde from hypothetical amplified irregularities. The basic model represents a periodic or wave-like perturbation to a horizontally stratified Chapman layer. Another ray path was calculated through another wave-length irregularity similar to the first, except that its amplitude is now 5% centered at 270 km. These ray paths show even more intense focusing and appear to support the self-amplification mechanism. Some estimates of the degree of range spreading produced by the enhanced irregularities can be derived from the ray path calculations. (J.C.W.)

7272 RADIO-REFLECTIVITY DETECTION OF ARTIFICIAL MODIFICATION OF THE IONOSPHERIC F LAYER. Cohen, Robert (ESSA Aeronomy Lab., Boulder, Colo.); Whitehead, J. D. J. Geophys. Res.; 75: 6439-45(1 Nov 1970).

A radio technique for studying the F-region ionospheric modifications produced by the Boulder heating experiment is presented. The measurement, radio reflectivity, is the relative power of radio echoes obtained from the perturbed ionosphere. The technique detects changes in electron temperature produced by the heating, as manifested by changes in the radio-frequency reflectivity of the heated volume at frequencies in the vicinity of the heating frequency. A bistatic deployment of diagnostic transmitter and receiver is used. Defocusing, scattering, and the increase in electron collision frequency are factors discussed for possible explanations of the observations. The explanation for the difference in effects on the ordinary and extraordinary waves is likely to be that the extraordinary exploring wave at a given frequency does not reach as great a height nor is it deviated to the same latitude as the ordinary wave at that frequency. Results are given for observations on May 27, 1970, and similar results were obtained on July 1 and 29, 1970. (J.C.W.)

7273 ENERGY DEPOSITION IN ARTIFICIAL IONOSPHERIC HEATING EXPERIMENTS. Thomson, J. Alex (Wayne State Univ., Detroit). J. Geophys. Res.; 75: 6446-52(1 Nov 1970).

The propagation morphology may be considerably simplified when the dielectric constant can be assumed independent of the angle between the wave normal and the magnetic field. An analysis is made of the heating of a vertically stratified plane ionosphere embedded in a near-vertical magnetic field and irradiated from below by a relatively narrow solid angle radio-frequency beam that is circularly polarized to generate only the extraordinary wave. Heating at frequencies below the penetration frequency is considered. Below the penetration frequency most of the absorbed energy is deposited close to the caustic. For an operating frequency well below critical, the electron density in the region of significant energy deposition can be approximated by a linear profile. It is shown that the energy deposition is spread over roughly a height interval of about 10% of the gradient distance, i.e., about 16 times the thickness of the full wave region. (J.C.W.)

7274 TURBULENCE STRUCTURE OF HIGH-β PERPENDICULAR FAST SHOCKS. Coroniti, F. V. (Univ. of California, Los Angeles). J. Geophys. Res.; 75: 7007-17(1 Dec 1970).

In a high-β plasma ion-cyclotron radius, dispersion forms a trailing wave train for a perpendicular fast shock. Collisionless dissipation is provided by the three-wave decay of the wave train into very oblique fast and parallel Alfvén waves. Particle thermalization results from Landau damping of oblique fast wave turbulence. The shock damping length to three-wave decay is many ion-cyclotron radii. Undamped Alfvén turbulence should persist far downstream from the shock. (auth)

7275 DIRECT CORRELATIONS OF LARGE-AMPLITUDE WAVES WITH SUPRATHERMAL PROTONS IN THE UPSTREAM SOLAR WIND. Scarf, F. L. (TRW Systems Group, Redondo Beach, Calif.); Fredricks, R. W.; Frank, L. A.; (and others). J. Geophys. Res.; 75: 7316-22(1 Dec 1970).

Results of direct correlations of magnetometer plasma-wave detector, plasma probe, and Lepedea proton data are given that were taken simultaneously by experiments aboard Ogo 5 during a large-upstream wave event on March 10, 1968. Direct correlation of Lepedea fluxes with magnetometer fluctuations shows that the large upstream wave amplitudes occur when enhanced fluxes of protons with $E_p \sim 4$ to 7 keV are present, and this suggests that

such suprathermal proton streams drive the hydromagnetic fluctuations. The presence or absence of ($f \lesssim 3$ kHz) electrostatic plasma wave turbulence in these regions was correlated with the degree of anisotropy of the 4- to 7-keV protons, and also with density gradients detected by the solar wind plasma probe. The measurements strongly indicate that the low-frequency electromagnetic waves are locally generated by energetic protons flowing upstream. It is demonstrated that the waves produce significant modulation in the incident solar wind parameters. (J.C.W.)

7276 LOCATION OF NEUTRAL LINE IN MAGNETOTAIL. Dessler, A. J.; Hill, T. W. (Rice Univ., Houston, Tex.). J. Geophys. Res.; 75: 7323-5(1 Dec 1970).

An interpretation is presented for the location of the neutral line in the magnetotail. It has previously been suggested that the neutral line lies relatively near the Earth. Direct spacecraft observations have been interpreted as indicating that the neutral line is generally beyond the orbit of the moon. Data were averaged over a significant fraction of the passage through the plasma sheet. The experiments may have been dominated by the effect of a geocentric gradient in the plasma sheet pressure. The component of magnetic field perpendicular to the neutral sheet (B_z in solar magnetospheric coordinates) was reported to be positive (northward) about 75% of the time when measured in the general vicinity of neutral sheet crossings on Explorers 33 and 35. Since field lines connecting through the neutral sheet must have a positive z component earthward of the neutral line and a negative component on the far side, the preponderance of positive z residuals between 20 and 70 R_E is presented as evidence of a more distant neutral line. (J.C.W.)

7277 POSSIBLE OBSERVATIONS AND MECHANISM OF VERY LONG DELAYED RADIO ECHOES. Crawford, F. W.; Sears, D. M.; Bruce, R. L. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 7326-32(1 Dec 1970).

Ionosonde records have suggested a new mechanism for the very long-delayed radio echoes returning from the ionosphere about 10 sec after transmission. It is proposed that the signals travel through the ionosphere at very low-group velocity under conditions in which collisional attenuation is offset by weak beam–plasma instability. First observations of what seem to be very long-delayed radio echoes, LDE, are reported. In the experiment, a 20-kW transmitter with a 100-msec cw pulse is manually pulsed, and then the LDE is recorded. After many hours of transmitting and recording, three LDE frequency-time plots were obtained in Jan. and Feb. 1970. (J.C.W.)

7278 SIMULTANEOUS OBSERVATIONS OF AN ENERGETIC ELECTRON EVENT IN THE MAGNETOTAIL BY THE VELA 3A AND IMP 3 SATELLITES. 1. Meng, C.-I. (Univ. of California, Berkeley); Hones, E. W.; Akasofu, S.-I. J. Geophys. Res.; 75: 7294-5(1 Dec 1970).

An analysis is made of the simultaneous observation made by Vela 3A and Imp 3 of an energetic electron event that began at 0456 UT on Apr. 8, 1966. The event coincided with the arrival of the auroral electrojet well inside the auroral oval, near Baker Lake from the vicinity of the auroral zone. The poleward motion of the electrojet is associated with the poleward expansion of the auroral oval resulting in the auroral bulge, giving rise to the hypothesis that the auroral bulge is associated with the expansion of the plasma sheet. The comparison of the data from both satellites suggests that the plasma sheet later contracted. (J.C.W.)

7279 SIMULTANEOUS OBSERVATIONS OF AN ENERGETIC ELECTRON EVENT IN THE MAGNETOTAIL BY THE VELA 3A AND IMP 3 SATELLITES. 2. Akasofu, S.-I. (Univ. of Alaska, College); Hones, E. W. Jr.; Meng, C.-I. J. Geophys. Res.; 75: 7296-8(1 Dec 1970).

Evidence has been presented (Hones, et al., 1970) that the expansion of the plasma sheet proceeds more rapidly along the neutral sheet than along the direction perpendicular to it. It was found that the top and bottom boundaries of the sheet move away from the neutral sheet at speeds ranging from 5 to 20 km/sec, while the expansion along the neutral sheet exceeds 40 km/sec. The events were observed by Vela 3A and Imp 3. The observations from these data are examined, and the simultaneous data are compared. An energetic electron event took place at about 2000 UT on Apr. 7, 1966. The progress of the magnetic disturbance is followed. Some new calculations of the speed of the boundary motion away from the neutral sheet is presented, and a comparison made with previous data. (J.C.W.)

7280 SOURCES FOR $H_3O^+ \cdot (H_2O)_n$ IONS IN THE D REGION. Swider, W. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res.; 75: 7299-7302(1 Dec 1970).

The creation of H_3O^+, $H_5O_2^+$, and $H_7O_3^+$ in the lower ionosphere is discussed and new sources are proposed. After reviewing previous reports, it is concluded that there are difficulties explaining the origin of $H_3O^+ \cdot (H_2O)_n$ ions in the D region beginning with O_2^+ ions and/or NO^+ ions. O_2^+ ions have too low a production rate under quiet solar conditions. Under disturbed conditions $O_2^+ \rightarrow O_4^+ \rightarrow H_3O^+ \cdot (H_2O)_n$ may be important, especially at night when O and $O_2(^1\Delta)$ are absent below 80 km. NO^+ ions can apparently coexist with $H_3O^+ \cdot (H_2O)_n$ ions to low altitudes. It is difficult to explain why NO^+ ions persist if $NO^+ \rightarrow H_3O^+ \cdot (H_2O)_n$. CH_3 and HCO may be present in the mesosphere and stratosphere. Both are subject to ionization by HL$y\alpha$ and their ions react with water to yield H_3O^+ ions. Until some technique eliminates the possibility that such species are present, their existence, or that of others, must be considered in examinations of the ionic structure of the D region. At the least, the chemistry of methane should not be ignored since $O + CH_4 \rightarrow CH_3 + OH$ may be an important source of OH [Cadle and Allen, 1970] and methane is a major hydrogen compound in the stratosphere [Bates and Nicolet, 1965]. (J.C.W.)

7281 SUDDEN IMPULSES IN THE MAGNETOSPHERE OBSERVED AT SYNCHRONOUS ORBIT. Patel, V. L.; Coleman, P. J. Jr. (Univ. of California, Los Angeles). J. Geophys. Res.; 75: 7255-60(1 Dec 1970).

ATS 1 data on the magnetic field in the equatorial plane at a geocentric distance of 6.6 Earth radii were used to study sudden impulses (si). Fifteen si events that produced effects at ATS 1 were examined. Records on the surface field at high and low latitudes were compared with the ATS 1 record for each event. (auth)

7282 POLARIZATION OF PROTON WHISTLERS. Smith, R. L. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 7261-6 (1 Dec 1970).

An experiment that separates whistler-mode waves into characteristic right- and left-hand circularly polarized components on a broad-band basis has shown that electron whistlers are nearly right-hand polarized and proton whistlers are nearly left-hand polarized, as is predicted by whistler theories. The method has application to the study of broad-band phenomena such as hiss and chorus, and should allow improved accuracy of ion density as measured from proton whistlers. (auth)

7283 SOFT PARTICLE FLUX ABOVE 130 km AT MID-LATITUDE. Hill, R. W.; Grader, R. J.; Seward, F. D.; Stoering, J. P. (Univ. of California, Livermore). J. Geophys. Res.; 75: 7267-71(1 Dec 1970).

Measurements were made from latitudes 22 and 17°N with rocket-borne, thin-window proportional counters of a variable flux of low-energy particles (electron energy greater than 3 keV) approaching the Earth from the southern half of the sky. These particles were detected on three separate rocket flights at altitudes above 120 km and at an L value of approximately 1.1. The three measurements differ in intensity but are very similar in spectral shape, with approximately an E^{-1} dependence. A typical flux value is 100 particles/cm^2 keV sec ster at an energy of 4 keV. These particles are of particular importance in low-energy x-ray astronomy experiments where they may be the dominant source of background in certain regions of the sky. (auth)

7284 ELECTRON TEMPERATURE FROM TOPSIDE PLASMA RESONANCE OBSERVATIONS. Warnock, J. M.; McAfee, J. R.; Thompson, T. L. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 75: 7272-5(1 Dec 1970).

The resonance observed by topside sounders near the plasma frequency is due to oblique electrostatic-wave echoes. Under certain conditions, two simultaneous echoes of slightly different frequencies occur and produce a beat pattern. The good agreement between the observed and theoretical beat patterns is good support for the theory. Furthermore, this beat pattern depends on electron temperature and provides a new method of measuring it. The possibility of continuous and accurate electron temperature measurement suggests sounder experiments designed to observe the individual electrostatic-wave echoes. (auth)

7285 EVIDENCE FOR PERSISTENT LONGITUDINAL ANOMALIES IN THE IONOSPHERIC ELECTRON CONTENT. da Rosa, A. V.; Waldman, H. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 7276-9(1 Dec 1970).

Columnar electron content versus longitude plots obtained from the observation of low orbiting satellites frequently exhibit local enhancements of electron content. Observations made during the summer of 1962 in the general neighborhood of Washington, D. C., revealed a period of over one week during which such local enhancements could be observed in successive passages of the satellite and seemed to persist throughout many days, apparently moving westward at a rate of about 1° longitude per day. These enhancements were elongated along a meridian, had a width of some 200 km, and covered more than 20° in latitude. (auth)

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7286 SPACE-CHARGE REGIONS ABOVE THE AURORA. Carlqvist, Per; Bostroem, Rolf (Royal Inst. of Tech., Stockholm). J. Geophys. Res.; 75: 7140-6(1 Dec 1970).

Observations have shown that field-aligned currents above auroras reach such magnitudes that space-charge regions of high potential drops can be expected. Effects of the electric fields associated with such a space-charge region are acceleration of auroral electrons and horizontal motions in the visual aurora. (auth)

7287 CONTINUITY OF THE AURORAL OVAL. Buchau, Jurgen (Air Force Cambridge Research Labs., Bedford, Mass.); Whalen, James A.; Akasofu, S.-I. J. Geophys. Res.; 75: 7147-60(1 Dec 1970).

The Flying Ionospheric Laboratory, a NKC-135 jet aircraft of the Air Force Cambridge Research Laboratories, made during the winter of 1969–1970 four flights that examined the continuity of the auroral oval. Two passed completely around the oval; two covered the afternoon–evening half of the oval. The all-sky camera photographs taken during these flights strongly suggest that the auroral oval, defined as the band of visible auroral arcs, is under moderately disturbed magnetic conditions ($\Sigma K_p > 10$), a continuous band around the geomagnetic pole. Under quiet conditions ($\Sigma K_p < 10$) discontinuities in the occurrence of aurora in the oval were observed in the morning, noon, and evening sector. Discontinuities in the morning sector were of temporal nature, the discontinuities in the noon and evening sector could be either temporal or spatial. (auth)

7288 PRECIPITATING ENERGETIC ELECTRONS AS AN IONIZATION SOURCE IN THE MIDLATITUDE NIGHTTIME D REGION. Potemra, T. A.; Zmuda, A. J. (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res.; 75: 7161-7(1 Dec 1970).

Satellite and rocket measurements of precipitating electrons with $E \geq 40$ keV are reviewed for middle latitudes during quiet conditions, and associated ionization rates and ion-pair densities are computed. The precipitating fluxes are highly variable, but even the lowest intensities may represent a significant source for the maintenance of the nighttime undisturbed D region. The energy deposited in the lower ionosphere by these electrons is consistent with the upper limit derived through consideration of the absence of specific night airglow intensities of the first negative system of N_2^+ at 3914- and 4278-A. (auth)

7289 OBSERVATIONS OF THE SUPRATHERMAL ELECTRON FLUX AND THE ELECTRON TEMPERATURE AT HIGH LATITUDES. Maier, E. J.; Rao, B. C. Narasinga (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 7168-74(1 Dec 1970).

Observations of suprathermal electrons in the energy range of 5 to 200 eV were obtained with retarding potential analyzers on Explorer 31 in the altitude range of 1700 to 3000 km over the northern high latitudes during the winter of 1965–1966. There are three distinct zones that mainly consist of a steady flux of photoelectrons in the midlatitudes, a high and variable flux containing precipitated particles in the auroral latitudes, and a low flux over the polar region. Evidence is presented to show that the magnetic field lines are closed at least up to $L = 7.7$ for these particles. The boundaries of precipitation vary with local time and are somewhat different from those of the auroral oval. The ambient electron temperature appears to be dependent on the level of flux in the auroral and polar region. (auth)

7290 MAIN ELECTRON TROUGH DURING THE RISING SOLAR CYCLE. Miller, N. J. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 7175-81(1 Dec 1970).

Results of an analysis of Explorer 22 Langmuir-probe measurements are presented for the winter periods between November 1, 1964, and February 15, 1967. The atmospheric phenomenon characterized by the data is the nightside main electron trough at 1000 km. The electron-density patterns imply that as the solar phase advanced, the mean quiet-time trough position was negligibly affected but the density increased as much as threefold. An increased variability among individual latitude profiles of electron density also accompanied the increase in mean sunspot number. The latitudinal distribution of electron temperature exhibited a nightside maximum at the trough that showed negligible changes in amplitude, width, and location over the period of analysis. The nightside temperature maximum can be related to the plasmapause phenomenon by invoking field-aligned heat conduction from the protonosphere. Potentially, downward heat conduction from hot protonospheric plasma within the plasmasphere can produce electron temperatures that increase with latitude at 1000 km, whereas outside the plasmasphere, where densities are greatly reduced, the temperatures can decrease with latitude because the low densities above 1000 km retard the downward heat conduction process. (auth)

7291 ANALYTICAL STUDY OF OBLIQUE ECHOES AT THE UPPER HYBRID RESONANCE. Graff, Philippe (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). J. Geophys. Res.; 75: 7193-8(1 Dec 1970).

The WKB technique developed by Fejer and Yu to study the oblique echoes received by topside sounders near the plasma frequency is applied to investigate the upper hybrid resonance. A model is chosen (the magnetic field parallel to the gradient of electron density with satellite velocity of arbitrary direction) that permits finding analytical expressions for the frequencies of the two Doppler-shifted received echoes and to show in a simple way their absence for $f_T > 2f_H$. A numerical application illustrates the influence of the main parameters: reception time, electron temperature, gradient of electron density, and direction of satellite velocity. (auth)

7292 EQUATORIAL SPREAD F: IMPLICATIONS OF VHF RADAR OBSERVATIONS. Farley, D. T. (Cornell Univ., Ithaca, N. Y.); Balsley, B. B.; Woodman, R. F.; McClure, J. P. J. Geophys. Res.; 75: 7199-7216(1 Dec 1970).

Scatter from field-aligned irregularities associated with equatorial spread F has been studied using the powerful 50 MHz radar at Jicamarca. It is found that these irregularities, that have a wavelength of 3 meters, first, at times can be generated anywhere in the F region, no matter with what vertical velocity the region is moving; second, have growth times of a few seconds or less; third, move at velocities comparable to that of the F layer; and fourth, may attain strengths of perhaps 10^7 to 10^8 times the background thermal level. There are also indications that there may be two types of irregularities, classified roughly as strong and weak, and that there may be a minimum threshold altitude that the bottom of the F layer must be above before the irregularities are first generated. These and other observed characteristics of the irregularities seem to rule out currently popular theories of their origin (the vertical drift instability suggested first by Martyn, mechanisms based on coupling between the E and F regions, gravitational instabilities, generation by hydromagnetic waves, and others) and several other well known types of plasma instability. Gradients of density and drift velocity remain as possible sources of instability, but at the moment it can only be speculated as to what may ultimately prove to be the correct explanation. (auth)

7293 STRONG TURBULENCE THEORY OF IONOSPHERIC CROSS-FIELD INSTABILITY. Williams, Robert H.; Weinstock, Jerome (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res.; 75: 7217-28(1 Dec 1970).

In the presence of external dc electric and magnetic fields that are perpendicular to each other, a weakly ionized plasma is subject to the so-called cross-field instability if there is an appreciable gradient of plasma density. The strong plasma turbulence theory of Dupree and Weinstock is used to develop the nonlinear theory of this cross-field instability, and the theory is applied to F-region irregularities in the ionosphere. As the waves grow, the nonlinearity is manifest in a growing enhanced ion-diffusion coefficient proportional to an integral of the wave spectrum. As the wave spectrum grows, the ordered motion of the ions, necessary to sustain the waves, is offset by the turbulent diffusion, so that eventually the wave growth stops and a stationary turbulent state is reached. The nonlinear dispersion relation, the stabilization time, and the asymptotic spectrum are calculated. (auth)

7294 IONOSPHERIC RESPONSE TO INTERNAL GRAVITY WAVES. 2. LOWER F REGION RESPONSE. Hooke, William H. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 75: 7229-38(1 Dec 1970).

The response of the lower F-region ionosphere to individual internal gravity waves is calculated as a function of the azimuth of wave propagation. This response is shown to be highly anisotropic, with the anisotropy itself depending on time of day, season, wave parameters, height, and geographic and geomagnetic location. Wave-associated changes in photoionization rate, and their dependence on the degree of alignment between the incoming solar radiation flux and surfaces of constant wave phase, play a dominant role in determining the anisotropy. Wave-associated changes in attachmentlike chemical loss are also important. The response of the lower F-region ionosphere to internal gravity waves therefore differs fundamentally from the response at higher levels, where ion lifetimes are long and wave-associated photochemical effects can be ignored, so that geomagnetic constraints on ion motion play the primary role in determining the anisotropy.(auth)

7295 IONOSPHERIC RESPONSE TO INTERNAL GRAVITY WAVES. 3. CHANGES IN THE DENSITIES OF THE DIFFERENT ION SPECIES. Hooke, William H. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 75: 7239-43(1 Dec 1970).

Changes in the densities of atomic oxygen and molecular ions produced by internal gravity waves are calculated as a function of the azimuth of wave propagation. Because these two ion species play different roles in the photochemistry of the lower F region, the waves change their densities differently, thus producing changes in F region ion composition. Wave-associated changes in photoionization rate appear to be quite important in this connection, with wave-associated changes in the loss rate β (and their temperature dependence) being somewhat less significant. (auth)

7296 CONTRIBUTION OF NONIONOSPHERIC CURRENTS TO THE QUIET DAILY MAGNETIC VARIATIONS AT THE EARTH'S SURFACE. Olson, W. P. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). J. Geophys. Res.; 75: 7244-9(1 Dec 1970).

The quiet day variations in the Earth's surface magnetic field caused by the magnetopause, neutral sheet, and ring currents have been calculated. All three model current systems produce variations similar to the "average S_q pattern" but smaller in magnitude. However, the systems combine to produce a 10-γ daily range during magnetically quiet periods. Because of the large observed fluctuations in solar wind parameters (which determine the strengths of these currents), it is suggested that magnetospheric currents may make a significant contribution to the day-to-day variability in S_q. (auth)

7297 COMPARISON OF SEVERAL MODELS OF THE EARTH'S HYDROGEN GEOCORONA WITH DATA OBTAINED FROM A SOLAR HYDROGEN LYMAN-ALPHA ROCKET SPECTROGRAPH. Jones, R. A. (Univ. of Colorado, Boulder). J. Geophys. Res.; 75: 6966-8(1 Dec 1970).

The absorption predicted by four current models of the Earth's hydrogen geocorona is compared with the absorption obtained by analyzing the solar H Ly-α spectrograms taken on an Aerobee rocket flight. Comparison shows that within the limits of observational error and theoretical assumptions, the data are consistent with all the models tested. (auth)

7298 ABSORPTION OF THE SOLAR LYMAN ALPHA LINE BY GEOCORONAL ATOMIC HYDROGEN. Meier, R. R.; Prinz, D. K. (Naval Research Lab., Washington, D. C.). J. Geophys. Res.; 75: 6969-79(1 Dec 1970).

Observations of the geocoronal hydrogen absorption feature at the center of the solar Lyman-α emission line, together with previously published absorption measurements, are analyzed and compared with the predictions of the Kockarts and Nicolet model and the Liwshitz model of the terrestrial hydrogen distribution. The results show that the hydrogen density at 100 km is between 1.25 and 2×10^7 cm^{-3} (for the Kockarts and Nicolet model) for a wide range of exospheric temperatures, that the geocoronal hydrogen abundance decreases with increasing exospheric temperature, that there is reasonable agreement with near-simultaneous satellite Lyman-α airglow observations, and that the absorption data are not accurate enough to distinguish between the models. Measurements of atomic hydrogen with mass spectrometers give densities that are larger by 2 orders of magnitude and therefore must be rejected in favor of the optical results. (auth)

7299 SOLAR WIND AND LOCATION OF SHOCK FRONT AND MAGNETOPAUSE AT THE 1969 SOLAR MAXIMUM. Egidi, A. (Univ., Rome); Formisano, V.; Palmiotto, F.; Saraceno, P.; Moreno, G. J. Geophys. Res.; 75: 6999-7006(1 Dec 1970).

A general survey of the average properties of interplanetary plasma from December 11, 1968, to April 13, 1969, and from August 27, 1969, to January 10, 1970, is presented, as observed by the European satellite Heos 1. The average values of the proton parameters are: number density, 4.3 p/cm^3; bulk velocity 409 km/sec; and most probable thermal speed, 33 km/sec. A map is presented of the observed magnetosheath traversals. A parabolic best fit of bow shock and magnetopause crossings gives, at the subsolar point, distances of 15.2 and 12.4 R_E from the Earth, respectively. The average plasma parameters and the positions of the discontinuity surfaces are compared with the results obtained by other satellites and space probes during the last period of low solar activity. (auth)

7300 INWARD MOTION OF THE MAGNETOPAUSE BEFORE A SUBSTORM. Aubry, Michel P.; Russell, Christopher T.; Kivelson, Margaret G. (Univ. of California, Los Angeles). J. Geophys. Res.; 75: 7018-31(1 Dec 1970).

On March 27, 1968, the UCLA magnetometer on board the inbound Ogo 5 satellite recorded an inward motion of the magnetopause by about 2 R_E in two hours. It is shown that this inward motion was associated with a reversal of the vertical component of the interplanetary field from northward to southward, the solar wind momentum flux remaining constant. The inward shift did not produce any compression of the magnetospheric cavity, which implies a transfer of magnetic flux from the dayside magnetosphere to the tail: the Imp 4 satellite saw the magnetic tail field increasing at the end of this interval and later the substorm-associated collapse of this field. The substorm was also recorded on the ground. It is emphasized that the position of the magnetopause after the inward shift cannot be explained in terms of the available numerical models. (auth)

7301 CONFIGURATION OF THE GEOMAGNETIC TAIL DURING SUBSTORMS. Fairfield, D. H.; Ness, N. F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 7032-47(1 Dec 1970).

Imp 4 vector magnetic field measurements and the geomagnetic AE index are used to study the configuration of the geomagnetic tail within 34 R_E and its variations during substorms. The existence of a depressed field magnitude region corresponding to the average position of the plasma sheet is confirmed and the average solar magnetospheric component of the field is found to be northward and independent of distance from the expected position of the neutral sheet for $|Z_{sm}| \lesssim 8$ R_E. The Z_{sm} component measured some distance from the equatorial plane is a measure of flux crossing the neutral sheet and can be studied as a function of time during substorms. Prior to and during the early phases of a substorm the tail-field magnitude increases and the northward field component decreases as the plasma sheet becomes thin. Later in the substorm the field magnitude decreases and the northward field component increases as the tail field relaxes to a more dipolar state. The greater number of field lines crossing the neutral sheet after the substorm is in agreement with the predictions of reconnection theories. Enhanced Z_{sm} components after substorms and during the rare occurrences of very quiet intervals suggest that many more field lines close near the Earth and fewer go into the geomagnetic tail at these times. (auth)

7302 OBSERVATIONS OF PROTON BURSTS IN THE MAGNETOTAIL WITH EXPLORER 35. Fennell, Joseph F. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 75: 7048-59(1 Dec 1970).

Energetic proton bursts ($E_p \geq 0.32$ MeV) are observed at 60 R_E in the magnetotail by Explorer 35. The intensity is usually anisotropic. The net proton flow as measured in the ecliptic plane is found to be most often nearly parallel or antiparallel to the local magnetic field and is sometimes toward and sometimes away from the Earth. Companion observations outside the bow shock by Explorer 33 show that the proton bursts are not of solar origin. One observation evidences possible proton flow away from the Earth, across the neutral sheet, and back toward the Earth parallel to the field in the ecliptic plane. The proton bursts have spectral e-folding energies of 50 to 110 keV and peak intensities of 14 to 420 $(cm^2 \text{ sec ster})^{-1}$, values that are similar to those for protons near the outer-zone trapping boundary. (auth)

7303 POLEWARD EXPANSION OF THE AURORAL OVAL AND ASSOCIATED PHENOMENA IN THE MAGNETOTAIL DURING AURORAL SUBSTORMS. Hones, E. W. Jr. (Los Alamos Scientific Lab., N. Mex.); Akasofu, S.-I.; Perreault, P.; Bame, S. J.; Singer, Sidney. J. Geophys. Res.; 75: 7060-74(1 Dec 1970).

The early phase of the auroral substorm is characterized by poleward motion of the poleward boundary of the auroral oval and by a poleward shift of the auroral electrojet. By using records from a Canadian north–south chain of magnetic stations, data from Vela satellites, and published observations by the Imp 2 satellite, first-approximation meridian profiles of the concurrent changes in the auroral oval and in the plasma sheet are obtained. It is shown that a sudden enhancement of energetic electrons ($E_e > 45$ keV) occurs in the magnetotail during the electrojet's poleward motion. In the 33 examples studied, the electron enhancement always occurred after the electroject reached dipole latitude 69°. The length of the delay from this time strongly depends on the perpendicular distance of the detecting satellite from the neutral sheet; specifically, a satellite within 1 or 2 R_E of the neutral sheet detects the electron enhancement about 20 minutes after this time or when the electrojet reaches dipole latitude ≈74°. The delay times depend less strongly on the satellite's radial distance from the Earth (within the radial distance range of the observations, i.e., 11 to 19 R_E). The sudden enhancement of energetic electrons is usually accompanied by a large increase of the number density of lower-energy plasma particles. The energetic electron enhancements are thus associated with mass transport through the magnetotail and not caused by the passage of a "disturbance" through the ambient plasma. The immediate source of the moving plasma is not known at present. (auth)

7304 EXPERIMENTAL STUDY OF MAGNETOSPHERIC MOTIONS AND THE ACCELERATION OF ENERGETIC ELEC-

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TRONS DURING SUBSTORMS. Lezniak, T. W.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). J. Geophys. Res.; 75: 7075-98(1 Dec 1970).

From a statistical study of 500- to 1000-keV electrons at synchronous orbit, it is concluded that near local midnight there exists a "fault line", west of which substorms are accompanied by geomagnetic inflation and east of which they are accompanied by collapse. Published studies have shown that the large, transient, substorm-associated fluxes of 50- to 150-keV electrons observed at synchronous orbit are produced near local midnight and subsequently drift longitudinally to other local times. A study of these lower-energy electron spikes and the concurrent geomagnetic data indicates that the electrons are produced during and within the geomagnetic collapse. Using measured magnetic data, it is concluded that the collapse is an inward convective surge of field lines with an average convective velocity estimated at 0.5 R_E/min. Magnetotail plasma particles of initial energies up to 10 to 20 keV are convected inward and energized tenfold; protons drift longitudinally westward (producing the observed evening inflation, and perhaps establishing a partial ring current), and electrons drift eastward. The model proposed is similar in many respects to others already proposed. However, the model exhibits the asymmetric inflation and collapse behavior about the fault line shown by observations at synchronous orbit. (auth)

7305 CONJUGATE OBSERVATIONS OF AN ELECTRON PRECIPITATION EVENT ASSOCIATED WITH THE SUDDEN COMMENCEMENT OF A MAGNETIC STORM. Leinbach, H. (ESSA Research Labs., Boulder, Colo.); Schmidt, R. J.; Brown, R. R. J. Geophys. Res.; 75: 7099-7104(1 Dec 1970).

The ionospheric absorption resulting from excess ionization in the lower ionosphere by energetic electrons precipitated during the sudden commencement of 0555 UT, August 11, 1967, has been observed by riometers. The data from Kotzebue, Alaska, and its conjugate at Macquarie Island demonstrate the close conjugacy of precipitation. An Alaskan north-south chain of riometers shows that the peak sc flux occurred at about L = 6.5. Taken together, the data indicate that the sc electrons are precipitated from the dayside trapping region by some pitch-angle diffusion mechanism. (auth)

7306 PLASMA DENSITIES IN THE THERMAL MAGNETOSPHERE DETERMINED BY USING HYDROMAGNETIC WHISTLERS. Higuchi, Y.; Jacobs, J. A. (Univ. of Alberta, Edmonton). J. Geophys. Res.; 75: 7105-16(1 Dec 1970).

The normalized dispersion-curve method has been used to determine plasma densities in the thermal magnetosphere from the dispersion characteristics of hydromagnetic whistlers. The propagation characteristics of ion-cyclotron waves in a thermal plasma with a magnetic mirror configuration have been investigated. In particular, the effects of the temperature of the magnetospheric plasma and its loss-cone distribution function have been taken into consideration in obtaining the travel time of an ion-cyclotron wave between a pair of conjugate points. From a modified normalized dispersion curve, plasma densities and the propagation path latitude have been estimated by the usual overlay technique. The effect of the thermal plasma is important if the frequency is close to the cyclotron frequency. The effect of curvature of the geomagnetic line of force on plasma densities is negligible for mirror ratios between 100 and 1000. Plasma densities are compared with those obtained by other authors. (auth)

7307 COMPARISON OF THE PREDICTED AND OBSERVED MAGNETIC FIELD AT ATS 1. Olson, W. P. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.); Cummings, W. D. J. Geophys. Res.; 75: 7117-21(1 Dec 1970).

The principal features of the quiet-day magnetic field variations at the position of the geosynchronous satellite ATS 1 are compared with the fields predicted by several magnetospheric models. To properly predict the ATS 1 field, the magnetopause model must include "tilt" effects (caused by the changing orientation of the earth's dipole axis with respect to the solar-wind direction), and the model of the tail field must allow the neutral-sheet currents to return on the magnetopause. Olson's models of the magnetopause and tail fields, which incorporate these features, are used to predict the daily and seasonal field variations at other geosynchronous longitudes. The fields predicted by these models account for most of the observed ATS 1 variations. (auth)

7308 FIELD-ALIGNED CURRENT AT 1100 km IN THE AURORAL REGION MEASURED BY SATELLITE. Armstrong, J. C.; Zmuda, A. J. (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res.; 75: 7122-7(1 Dec 1970).

A satellite measurement of a transverse magnetic disturbance in the auroral oval is presented and analysed in terms of field-aligned currents. The data are found to fit qualitatively a two-sheet current model proposed by R. Boström. Current flows into the ionosphere along the higher-latitude sheet and out along the lower-latitude sheet; densities of 8.72×10^{-6} and 8.72×10^{-5} amp/m^2 are required, respectively, to produce the observed magnetic disturbance. (auth)

7309 ENERGY SPECTRA OF AURORAL ZONE PARTICLES. Chase, L. M. (Univ. of California, Berkeley). J. Geophys. Res.; 75: 7128-39(1 Dec 1970).

Two sounding rockets were launched into auroral breakups near local midnight and one rocket was launched into a 2.5-db riometer absorption event at local noon. The rockets were instrumented to measure the energy spectra of electrons and protons. Results show that electron fluxes in the auroral zone resemble electron fluxes in the plasma sheet, both in the shape of energy spectra and in the magnitude of flux, which indicates that the plasma sheet may be the source of auroral zone electrons. The proton fluxes in these two regions are quite different. Thus the plasma sheet probably is not the source of auroral zone protons. Time variations of 1-keV electrons and protons were coherent, which indicates similar precipitation mechanisms for these two types of particles. The source of 1-keV electrons was found to have a wider spatial extent than the source of 10-keV electrons. During auroral breakup, electron precipitation was isotropic over the upper hemisphere while the protons were anisotropic, with more flux at 90° than at 0°. (auth)

7310 NONTHERMAL HEATING IN THE TWO-FLUID SOLAR WIND MODEL. Hartle, R. E. (Goddard Space Flight Center, Greenbelt, Md.); Barnes, Aaron. J. Geophys. Res.; 75: 6915-31(1 Dec 1970).

The two-fluid solar wind model predicts values for wind speed and proton temperature that are lower than average observed values; however, the predictions are consistent with the empirical relation of Burlaga and Ogilvie, in which the square root of the proton temperature is proportional to the wind speed. Since observed values of wind speed and proton temperature are typically higher than those of the two-fluid model, it is concluded that energy must be supplied by dissipation of nonthermal energy from an external source. The two-fluid model is therefore extended by including ad hoc an energy source in the proton heat equation whose strength and spatial distribution is varied to determine the general requirements of such a source. The main features of our results are: heat deposited inside the heliocentric radius $r \simeq 4\ R_s$ results in a significant increase in wind speed with negligible increase in proton temperature; depositing heat over the range $r \gtrsim 25\ R_s$ results in a large increase in proton temperature and negligible increase in wind speed. By depositing heat over the extended range $2\ R_s \lesssim r \lesssim 25\ R_s$, solar wind speeds and proton temperatures can be brought into direct correspondence with the empirical results of Burlaga and Ogilvie. On the basis of this model, it is concluded that primary energy deposition should take place inside $r \simeq 25\ R_s$. (auth)

7311 EFFECT OF INTERSTELLAR NEUTRAL HYDROGEN ON THE TERMINATION OF THE SOLAR WIND. Semar, Cary Lloyd (Univ. of Houston, Tex.). J. Geophys. Res.; 75: 6892-8(1 Dec 1970).

The effect of charge exchange and photoionization of neutral hydrogen penetrating the supersonic solar wind region from the interstellar medium is taken into account by constructing appropriate source terms for the equations of the flow. The equations are solved numerically for densities of 1, 5, and 10 cm^{-3} in the interstellar medium. It is shown that the size of the supersonic solar wind region varies with these densities from 50 to 8 AU in the apex direction if the momentum of the incoming neutral hydrogen is neglected. If the momentum of the incoming neutral hydrogen is taken into account, it is found to be sufficient to halt the flow of the solar wind at about 45 AU for an interstellar neutral hydrogen density of 1 cm^{-3}. (auth)

Low-Temperature Physics and Cryogenic Equipment

Superfluidity

7312 (TID-25587) CHARGE MOBILITIES IN SUPERFLUID HELIUM UNDER PRESSURE. Brody, Burton Alan (Michigan Univ., Ann Arbor). 1970. 125p. Dep. NTIS.

Thesis.

Measurements are presented of the mobilities of positive and negative charge carriers and the ratio of these at each point, at elevated pressures in He II. The data proceed along ten isotherms at 1.315 to 1.83°K from the vapor pressure to the melting curve, and along cross-hatching isobars at intermediate pressures through the lambda line as well. This mapping extends through the regimes of roton scattering kinetic theory and viscous dy-

namics, accommodating to various analyses of mobility theories and charge carrier models, and of the roton parameters under pressure. All analyses are not pursued in depth, but almost five hundred mobility data are tabulated and plotted, for each carrier separately and as ratios, against pressure and inverse temperature, to reveal previously unobserved structure. The technique is a measurement of the drift time for charge carriers of either sign, generated by a 0.46 mCi americium alpha source and received by a fast electrometer as a current pulse of less than 10^{-11} A with a signal-to-noise ratio of less than unity. The time-of-flight varies from a fraction of a second to several seconds for a distance of five and a half centimeters under a uniform field of 100 V/cm. Signal-to-noise is improved by signal averaging with a multichannel pulse height analyzer/time averaging computer, whose analog output is measured by hand. (auth)

7313 (TID–25595) DETECTION OF SINGLE QUANTIZED VORTEX LINES IN ROTATING LIQUID HELIUM. Packard, Richard Erwin (Michigan Univ., Ann Arbor). 1969. 79p. Dep. NTIS.

Thesis.

The appearance of individual quantized vortex lines was detected in liquid He II in narrow (~1 mm) diameter, rotating, cylindrical vessels which were slowly accelerated from rest. The angular velocities where the lines appear are qualitatively consistent with theory, based upon minimization of the free energy. However, it was found that the detailed behavior of the He II is quite history-dependent and cannot be uniquely determined from existing theory. The detection technique involves trapping electrons on the vortex lines for a fixed length of time. A subsequent measurement of the amount of charge trapped provides an indication of the number of vortex lines present. In order to detect the small amount of charge trapped on a single line, the trapped electrons were injected through the meniscus and a proportional counter was developed to detect them in the vapor. Vortex lines were observed that persist after stopping rotation. The apparent destruction of vortices by mechanically disturbing the rotating container was also observed. (auth)

7314 VELOCITY OF SECOND SOUND NEAR THE LAMBDA POINT. Johnson, David Lawrence. Vancouver, B. C.; Univ. of British Columbia (1969).

Thesis.

Direct measurements were made of the velocity of second sound in liquid helium over the temperature range $T_\lambda - T$ from 1.3×10^{-2} to 5×10^{-6} K. Using previously determined relationships for the specific heat, superfluid density, and thermal conductivity near the lambda point, consistency was demonstrated between the measurements, velocities predicted by superfluid hydrodynamics, and certain scaling-law predictions. (Diss. Abstr. Int., B)

7315 THEORY OF THE EXCITATION SPECTRUM OF SUPERFLUID HELIUM. Straley, Joseph Paul. Ithaca, N. Y.; Cornell Univ. (1970). 116p. University Microfilms Order No. 70-12,652.

Thesis.

Theories of the excitation spectrum for superfluid helium are critically reviewed, emphasizing the demonstration of the identity of the single-particle and phonon spectra, the success of these theories in accounting for qualitative features of the spectrum, and the possibility of quantitative application of the theories. (Diss. Abstr. Int., B)

7316 SCINTILLATIONS IN LIQUID HELIUM BELOW 1°K. Fischbach, Melvyn Robert. Charolettsville, Va.; Univ. of Virginia (1969). 84p. University Microfilms Order No. 70-8086.

Thesis.

The experiments described were undertaken in an attempt to understand the observed inhibition of alpha-particle-induced scintillations in superfluid helium. The experimental results exhibit a steady decrease in intensity as the temperature is reduced to 0.9°K with a subsequent plateau as it is reduced further to 0.3°K. In addition, it was found that this decrease is due to delayed photon emission. Theoretical considerations demonstrated that a smaller decrease with decreasing temperature in He I is not attributable to reduced recombination luminescence. For temperatures below the lambda transition it was shown that recombination may be responsible, although no attempt at numerical correlation could be made. However, an experiment employing an applied electric field in the region of the alpha tracks yielded data that enable the coefficient of recombination to be calculated. (Diss. Abstr. Int., B)

7317 VELOCITY OF SECOND SOUND AND THE INERTIAL MASS OF ^{3}He IN ^{3}He–^{4}He MIXTURES. Brubaker, Nickson Randolph. Columbus, Ohio; Ohio State Univ.; Oxford, Ohio; Miami Univ. (1969). 152p. University Microfilms Order No. 70-13,989.

Thesis.

The velocity of second sound was measured between 0.028 and 0.6°K in ^{3}He–^{4}He mixtures with ^{3}He concentrations from 0.143 to 6.278%. The measurements were made under the vapor pressure and at 10 and 20 atm. Second sound was generated by an electrostatic transducer with a porous diaphragm which was permeable to the superfluid. The diaphragm pores were small enough that the moving diaphragm could directly create density fluctuations in the normal fluid without creating fluctuations in the total density. The second sound receiver was an identical transducer operating as a capacitive microphone. The velocity was determined by measuring the time of flight of single pulses of second sound. A hydrodynamic equation derived by Khalatnikov for the velocity of second sound was solved to give an expression for the normal fluid density in terms of the second sound velocity and the derivative of the osmotic pressure with respect to the ^{3}He number density. By defining the inertial mass of one ^{3}H excitation in solution by the relation $m_i = \rho_n/n_3$, the inertial mass was obtained as a function of concentration and temperature for the vapor pressure data. The concentration dependence was explained in terms of a simple model that pictures additional ^{3}He atoms sharing the hydrodynamic backflow of superfluid ^{4}He past the moving ^{3}He atoms. This results in a decrease in the inertial mass per ^{3}He atom as the concentration is increased. The temperature dependence was accounted for by assuming the existence of a small p^4 term in the energy spectrum of the ^{3}He excitations. (Diss. Abstr. Int., B)

7318 GAUGE INVARIANCE IN THE THEORY OF SUPERFLUIDITY. Sarfatt, Jack. Riverside, Calif.; Univ. of California (1969). 63p. University Microfilms Order No. 70-11,993.

Thesis.

The hydrodynamic behavior of pure superfluid helium at 0°K is studied with a view toward gaining a clearer understanding of vortex nucleation, vortex core structure, backflow, the rotating superfluid, and film creep. An ansatz reminiscent of the gauge-invariance techniques encountered in quantum electrodynamics is used that gives a set of classical coupled nonlinear equations to replace the rigorous hierarchy of equations of motion of the reduced density matrices. The nonlinear equations describe a complex "order parameter" field coupled to an equation describing a velocity field that arises from the "depletion" and possesses curl, as well as to a scalar field, also arising from the "depletion," which is reminiscent of the scalar potential in electrodynamics. The equations of the present model bear a striking similarity to the phenomenological Landau–Ginzburg equations for type-II superconductors. The theory has two characteristic lengths, whereas previous models of He II have only one length. The structure of the equations resembles that of a charged liquid in which density fluctuations play the role of charges. Consistency with hydrodynamics rules out "radiative" like solutions for the solenoidal flow field, which is shielded in a He II analog of the Meissner effect. Appropriate boundary conditions ensure that the "depletion" fields exist only in a region where there is superfluid. The electrodynamics analogy suggests a mechanism for vortex nucleation, which has been missing in previous models. Feynman–Cohen dipolar backflow occurs naturally in this model. The vorticity field in the vortex core is calculated, and the oversimplified picture of a mathematical singularity given in earlier models is improved upon. It has been long recognized that the classic Abrikosov solution for type-II superconductivity also describes the vortex pattern in rotating He II. Previous models of He II have not been able to account correctly for this. The present model, however, contains this result. (Diss. Abstr. Int., B)

7319 THIRD SOUND IN UNSATURATED FILMS OF SUPERFLUID HELIUM. Fraser, James Cavender. Los Angeles; Univ. of California (1969). 141p. University Microfilms Order No. 70-12,008.

Thesis.

The velocity of third sound in unsaturated films of superfluid helium was measured at several temperatures between 1.12 and 2.05°K. Helium films from 4 to over 100 atomic layers were adsorbed on glass substrates. The third sound waves were generated thermally. They were detected by sensing the very small temperature oscillations that accompany the hydrodynamic wave. The velocity was measured by the time of flight of sine wave pulses whose frequency ranged from 500 Hz to 5 KHz. The velocity was found to be less than that predicted by Atkins' hydrodynamic theory of third sound in saturated helium films, which is based on the thermodynamic properties of the bulk liquid. Atkins' equations were modified to take into account a variation of the thermodynamic properties of the film with thickness. An analysis of the velocity data yielded the average superfluid density as a function of film thickness. The reduction of the superfluid fraction was compared to the Ginzburg–Pitaevskii theory

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of superfluidity, and a quantity that can yield values of the characteristic healing length of the theory was determined from the data. The presence of a solid or normal fluid layer was taken into account. If the assumption is made that there is a solid monatomic layer of helium at the substrate and that the superfluid order parameter vanishes, both at the solid layer and at the free surface of the film, then the healing lengths obtained from the data are given by $2.9 \times 10^{-9}\ T/\rho_s$ (c.g.s.). The third sound signal was found to disappear when the velocity was near or at maximum. This disappearance is interpreted as due to the loss of the superfluid properties of the film. The thickness at which this occurs is a function of temperature and agrees with the thickness for the onset of superflow determined by other mass-flow and heat-flow experiments. There is no evidence from independent experiments for a latent heat as large as would be implied by the rapid drop of the superfluid density to zero, inferred from the large sound velocity near onset. This has led to the conclusion that the superfluid fraction is finite at onset. Its value at onset was determined for the first time by these measurements to be a constant equal to about $\frac{3}{8}$. The onset is discussed in terms of a fluctuation theory developed by Revzen that predicts a temperature-independent nonzero superfluid fraction at the onset of superflow. The Ginzburg–Pitaevskii theory does not predict this behavior. Preliminary measurements of the attenuation of third sound gives values in reasonable agreement with the attenuation predicted by a theory recently developed by Bergman. The attenuation was observed to rise sharply as the onset was approached. This suggests that there may be an additional mechanism for attenuation associated with fluctuations. No inconsistency resulted from the application of a hydrodynamic theory to films as thin as 4 atomic layers. (Diss. Abstr. Int., B)

7320 HYDRODYNAMICS OF A SUPERFLUID CONDENSATE. Herold, Jack Sachs. Riverside, Calif.; Univ. of California (1969). 76p. University Microfilms Order No. 70-11,986.
Thesis.

Starting from the equation of motion for the first reduced density matrix describing a system of condensed bosons, a dynamical equation of motion is developed for the "order parameter" that couples to the noncondensate part of the first-reduced density matrix. The derivation requires no assumptions concerning the strength of the potential nor is it limited to any particular temperature region. The equations of Gross or of Ginzburg and Pitaevskii follow in an appropriate approximation. A detailed investigation of the coupling term gives an equation identical in form to one of the Landau–Ginzburg equations of superconductivity. (Diss. Abstr. Int., B)

7321 CAN A SOLID BE SUPERFLUID? Leggett, A. J. (Univ. of Sussex, Brighton, Engl.). Phys. Rev. Lett.; 25: 1543-6 (30 Nov 1970).

It is suggested that the property of nonclassical rotational inertia possessed by superfluid liquid helium may be shared by some solids. In particular, nonclassical rotational inertia very probably occurs if the solid is Bose-condensed as recently proposed by Chester. Anomalous macroscopic effects are then predicted. However, the associated superfluid fraction is shown to be very small (probably $\lesssim 10^{-4}$) even at T = 0, so that these effects could well have been missed. Direct tests are proposed. (auth)

7322 EXPERIMENTAL EVIDENCE FOR A TWO-ROTON BOUND STATE IN SUPERFLUID HELIUM. Greytak, T. J.; Woerner, R.; Yan, J.; Benjamin, R. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 25: 1547-50(30 Nov 1970).

Raman scattering is used to study roton pairs in liquid helium at 1.2°K. It is found that the energy required to create two rotons is less than twice the energy of a single roton. This result can be explained by the existence of a two-roton bound state. Comparison of our spectra with theoretical calculations gives a binding energy of (0.37 ± 0.10)°K and shows that the pair is in a D state (L = 2) of angular momentum. (auth)

7323 EXCITATION ENERGY IN LIQUID HELIUM II. Kebukawa, Takeji; Yamasaki, Shuichiro; Sunakawa, Sigenobu (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 44: 565-73(Sep 1970).

Previously, the excitation spectrum in liquid helium II at 0°K was studied from first principles by taking into account the contribution from the phonon–phonon interactions, where use was made of a simple square-well potential as an attraction potential between helium atoms. Here, the calculation of the excitation energy is improved by making use of the Morse potential which is more realistic than the square-well potential. The result is in better agreement with the experimental spectrum than the previous studies. The lowest-order ground-state energy is calculated numerically to yield a value in fairly good agreement with the observed value. (auth)

7324 THERMODYNAMIC BEHAVIOR OF A MODEL HAMILTONIAN FOR A MIXTURE OF ^{3}He AND ^{4}He. Soda, Toshio; Sawada, Katuro; Nagata, Tsuneo (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 44: 574-9(Sep 1970).

The model treatment of a previous work for a mixture of the boson and fermion systems is extended to finite temperatures, using sum rules. The Fermi liquid theory is used in the sound-velocity expression to express the stability region of both systems for the coexistence. The boundary curve for the stability region in the lower concentrations of ^{3}He up to about 30% fits the phase diagram of the ^{3}He–^{4}He mixture well, comparing present theory results with those obtained using the Fermi liquid theory. However, beyond this concentration, the approximation loses its validity, and there is a deviation from the experimental curve. A possible remedy for this is discussed. (auth)

7325 NEUTRON SCATTERING FROM LIQUID HELIUM II AT LARGE MOMENTUM TRANSFER AND THE CONDENSATE FRACTION. Kerr, W. C. (Argonne National Lab., Ill.); Pathak, K. N.; Singwi, K. S. Phys. Rev., A; 2: 2416-26(1 Dec 1970).

A simple theory of neutron scattering from liquid He II at zero temperature for large momentum transfers is described. The theory is based on a generalized mean-field approximation involving the polarization potential and the screened response function. The latter, instead of having a free-particle form, is assumed to be a sum of Gaussian functions, weighted by the momentum distribution function appropriate for liquid helium. The zero and third moments of the scattering law determine the polarization potential and the width of the Gaussians. Numerical calculations have been made for the dynamical structure function $S(q,\omega)$ for different values of the condensate fraction. Both the width and the peak position of $S(q,\omega)$ in the range of momentum transfers 2.5 to 9 Å^{-1} are in fair agreement with experiment for a 6% condensate fraction. Calculations have also been done for q values as large as 20 Å^{-1} for three different values of the condensate fraction, including 0. For a condensate fraction of 6% or larger, the contribution of the condensate to $S(q,\omega)$ becomes separated from that of the noncondensed particles at these large-q values. The separation is distinct enough that it should be experimentally observable. (auth)

7326 TEMPERATURE, PRESSURE, AND CONCENTRATION DEPENDENCE OF THE OSMOTIC PRESSURE OF DILUTE ^{3}He–^{4}He MIXTURES. Landau, J.; Tough, J. T.; Brubaker, N. R.; Edwards, D. O. (Ohio State Univ., Columbus). Phys. Rev., A; 2: 2472-82(1 Dec 1970).

The osmotic pressure of ^{3}He–^{4}He mixtures was measured at temperatures 0.027 to 0.65 K, for concentrations up to 10-mole % ^{3}He, and for hydrostatic pressures of 0.26, 10, and 20 atm. The osmotic pressure was measured directly with a sensitive specially designed diaphragm pressure gauge. The temperature and concentration dependence of the osmotic pressure is in fair agreement with the effective interaction theory proposed by Bardeen, Baym, and Pines (BBP). It also agrees with a simple empirical model that avoids the complicated calculations involved in obtaining the thermodynamic properties at finite temperatures from the BBP theory. The model fits the temperature dependence of other thermodynamic properties of solutions. The osmotic pressure at absolute zero at 10 and 20 atm. is used to determine the ^{3}He effective mass and somewhat speculative values of the BBP quasiparticle interaction V(k) under pressure. The interaction under pressure is found to have a minimum at a nonzero value of k, and it may give rise to a "supermobile" transition at comparatively high temperatures. (auth)

7327 ac JOSEPHSON EFFECT IN SUPERFLUID HELIUM IN TERMS OF ACTION-ANGLE VARIABLES IN QUANTUM STATISTICS: A MODEL CALCULATION. Biswas, A. C.; Warke, C. S. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., A; 2: 2568-70(1 Dec 1970).

Applying the formalism of action-angle variables in quantum statistics to an exactly solvable model Hamiltonian, explicit expressions relating the superfluid tunneling current and the corresponding phase coupling between two helium baths connected by an orifice are treated. The relevance of the calculations to a recent experiment is pointed out. (auth)

7328 COUPLING BETWEEN PRESSURE AND TEMPERATURE WAVES IN LIQUID HELIUM. Fritz, G. F.; Pollack, Gerald L. (Michigan State Univ., East Lansing). Phys. Rev., A; 2: 2560-7(1 Dec 1970).

When the thermal expansion coefficient (α) is retained in the linearized hydrodynamic equations of the two-fluid model of superfluid liquid helium, pressure and temperature waves are not independent. Thus a periodically varying temperature source produces not only temperature waves in liquid helium, but also

two pressure waves p'_1 and p'_2, which propagate at the velocity of first and second sound, respectively. Similarly, a vibrating diaphragm produces not only pressure waves but also two temperature waves T'_1 and T'_2, which also propagate at the velocity of first and second sound, respectively. Lifshitz has shown that the amplitudes of these cross modes should be proportional to α. An investigation of this coupling has been made by observing and studying the two pressure waves p'_1 and p'_2 produced by a heater and the temperature wave T'_2 produced by a capacitor microphone. The temperature dependence of the amplitude of these waves has been studied using both pulse and standing-wave techniques in the temperature range from 1.2 K to the λ point. Good agreement with theory has resulted only for the p'_1 mode. (auth)

7329 COMMENT ON DAMPING OF A HEATED OSCILLATING CYLINDER IN He II. Hunt, T. K. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., A; 2: 2577-8(1 Dec 1970).

Recently Payne reported on experiments verifying the existence of the "heat-exchange torques" predicted by Penney and Overhauser. His results were obtained by measuring the heat-induced changes in the logarithmic decrement of a cylindrical torsion pendulum immersed in He II and seem to be in good agreement with the measurements of the torque on heated cylinders in rotating superfluid helium reported earlier by the present author. Payne claims however, that these earlier measurements are open to serious question because of a torque-producing mechanism which he calculates will be effective if the test cylinder is heated nonuniformly. Here, it is shown that the physical model chosen for Payne's calculation is unrealizable, and further, that the mathematics is carried through incorrectly. When properly analyzed, the mechanism he proposes yields zero net torque for all distributions of the heat input and could not, therefore, have been a complicating factor in the earlier experiments. (auth)

Superconductivity

Refer also to abstracts 7407, 7412, and 7491.

7330 (IPP-4/71) APPARATUS FOR I_c,H CHARACTERISTIC MEASUREMENTS ON HIGH-CURRENT SUPERCONDUCTING SHORT SAMPLES. Amenda, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar 1970. 31p. (In German). Dep. NTIS (U. S. Sales Only).

A setup is described which allows measurements on superconducting short samples in fields up to 52 kOe and currents up to 3500 A. The 52 kOe coil has a 50-mm bore (diameter) and 240-mm length. An axial length of 100 mm is available for the centered location of the sample. Besides the presentation of data describing the setup performance, the problem of the sample contacts is treated in detail, especially with regard to the heating influence of the environment on the sample. A description is given of the technique used, measurement process, and evaluation. (auth)

7331 MAGNETIC FIELD MODULATION OF THE MICROWAVE IMPEDANCE OF Pb SUPERCONDUCTING FILMS. Indovina, P. L.; Onori, S.; Tabet, E. (Istituto Superiore di Sanita, Rome). Solid State Commun.; 8: 1721-4(1 Nov 1970).

Critical surface field of Pb films was measured by means of a high-sensitivity differential technique. Satisfactory agreement is found with the Saint-James–de Gennes theory extended to films. The onset of surface superconductivity was investigated in the range between the reduced temperature t from 0.51 to 0.99. (auth) (UK)

7332 SUPERCONDUCTING PROXIMITY EFFECT CURRENTS IN INDIUM ABOVE ITS TRANSITION TEMPERATURE. Trenholme, John Burgess. Pasadena, Calif.; California Inst. of Tech. (1970). 119p. University Microfilms Order No. 70-12,441.

Thesis.

The superconducting proximity effect, in which superconductivity diffuses from a superconductor into an adjacent nonsuperconductor, was investigated using the SNS sandwich method in order to test the predictions of the de Gennes–Werthamer theory of temperature dependence of the Ginzburg–Landau equation. Sandwiches were made in which Pb injected superconductivity into a central layer of In, so that the maximum lossless current through the In could be found as a function of temperature down to the In transition temperature (3.4 K). Techniques were used to insure uniform current flow, and to avoid annealing. The log of the critical current density of the sandwiches decreased linearly with temperature above the In transition; the current became much larger below the transition. The de Gennes–Werthamer theory was extended by the addition of the nonlinear term in the Ginzburg–Landau equation; exact solutions of the one-dimensional Ginzburg–Landau equation in the presence of current (but with $\underline{A} = 0$) were used to find the theoretical temperature variation of the critical current density. The experimental and theoretical curves showed the same linear behavior (although there were slope and value variations), thus verifying the de Gennes–Werthamer theory near the transition temperature of a material. (Diss. Abstr. Int., B)

7333 KNIGHT SHIFT IN DIRTY SUPERCONDUCTING ALUMINUM FILMS. Fine, Howard Lawrence. New York; Yeshiva Univ. (1969). 144p. University Microfilms Order No. 70-11,604.

Thesis.

The Bardeen–Cooper–Schrieffer theory of superconductivity predicts that the electronic spin susceptibility in the superconducting state will vanish at zero temperature. Early Knight shift measurements on various metals, including aluminum, failed to confirm this prediction. More recent measurements on very pure aluminum in films, however, indicate that the susceptibility vanishes at zero temperature. In order to resolve the discrepancy between the early and recent aluminum data, experiments were performed on aluminum films of varying thicknesses and mean free paths. The data show that the spin susceptibility in dirty superconducting aluminum does indeed vanish in accordance with the BCS theory. The nonvanishing susceptibility in metals other than aluminum has been adequately explained as a manifestation of spin–orbit scattering. An explanation is presented for the nonvanishing result observed in the early aluminum experiment. (Diss. Abstr. Int., B)

7334 DETECTION OF ALPHA PARTICLES WITH SUPERCONDUCTING TUNNEL JUNCTIONS. Wood, Gordon Harvey. Vancouver, B. C.; Univ. of British Columbia (1969).

Thesis.

A superconducting thin film tunnel junction ($Sn/SnO_2/Sn$) of total thickness 4000 Å, area 7×10^{-4} cm^2 and normal (4.2 K) resistance 77 mΩ was prepared on a glass substrate. When cooled to 1.2 K, the junction was biased on 0.3 mV where, the Josephson supercurrent having been suppressed with a magnetic field, the junction dynamic resistance had its maximum value of 9.3 Ω. The junction was then bombarded with 5.1-MeV alpha particles and the resulting pulses induced in the tunneling current were observed to have amplitudes up to 19 times the preamplifier-dominated rms output noise level. For purposes of analysis, it was assumed that the induced current pulse had the form $i(t) = i_0 \exp(-t/\tau)$, $t \geq 0$. With this form of the current pulse and the known transfer function of the transmission line–amplifier system, it was calculated that for all pulses $\tau = (1.38 \pm .33) \times 10^{-7}$ sec and that for the largest amplitude pulses, corresponding to an energy loss $\Delta E_\alpha \leq 2.75$ MeV, i_0 lay in the range $20 \leq i_0 \leq 26$ μA with a most probable value of 22 μA. With this value of i_0 and $\Delta E_\alpha = 2.75$ MeV, an upper limit of 8.2×10^{-3} eV was assigned to the value of w(Sn), the average energy expended by the alpha particle to excite a quasi-particle pair in superconducting tin at 1.2 K. A tentative theory of the superconducting tunnel junction charged-particle detector is given, and the cryogenic and electronic apparatus required for the measurements are described. Details related to thin-film-junction fabrication technology and interpretation of dc experimental results are discussed in four appendices. (Diss. Abstr. Int., B)

7335 DEPENDENCE OF THE CRITICAL CURRENT ON THE DISLOCATION DENSITY. Baramidze, G. A.; Saralidze, Z. K. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 12: 179-81(5 Sep 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 263-5(5 Sep 1970).

The binding energy of the vortex of a superconductor was obtained as a function of the dislocation density, assuming the dislocations to have a homogeneous and isotropic distribution, on the basis of a simple model of the interaction between the vortex and the elastic fields, with account taken only of the so-called volume factor. The vortex is represented in the form of a cylindrical region with a homogeneous spontaneous dilatation equal to the relative change of the unit-cell volume during the phase transition. The relation obtained is expected to hold for strongly deformed samples in which the dislocation distribution is close to homogeneous. (M.H.R.)

7336 SUPERCONDUCTIVITY OF Au–Ge FILMS OBTAINED BY EVAPORATING THE ALLOY WITH A LASER PULSE. Alekseevskii, N. E.; Zakosarenko, V. M.; Tsebro, V. I. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.) 12: 157-9(5 Sep 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 228-31(5 Sep 1970).

Measurements were performed on films obtained from an Au–Ge alloy condensed on a substrate maintained at the temperature of liquid nitrogen or helium. In the films obtained by the two methods, a superconducting transition was observed at 2.7°K. (M.H.R.)

7337 REVERSIBLE CHANGE OF SUPERCONDUCTING TRANSITION TEMPERATURE OF U_6Fe INDUCED BY NEUTRON IRRADIATION. Voronova, I. V.; Mikhailov, N. N.; Skvortsov, A. I. JETP Lett. (USSR) (Engl. Transl.); 12: 145-7(5 Sep 1970). Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 209-13(5 Sep 1970).

The effect of disordering on T_c of bulky superconductors is investigated. Data are presented on the variation of T_c of U_6Fe samples following neutron bombardment and a subsequent annealing. (M.H.R.)

7338 INSTABILITIES ARISING IN A FORCE-FREE CURRENT FLOW IN THE SUPERCONDUCTING ALLOY Ti–22 at. PERCENT Nb. Karasik, V. R.; Vereshchagin, V. G.; Nikitina, G. T.; Rusinov, A. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 12: 201-4(20 Sep 1970). Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 297-302(20 Sep 1970).

In studies of the critical currents of wire made of the alloy Ti–22 at. % Nb, a sharp dip was observed on the plot of the critical current against the external magnetic field parallel to the wire axis. The behavior of the critical current in the region of the dip is characterized by two singularities: the value of j_c ($j_c = I_c/\pi R^2$, where R is the wire radius) at the first destruction of the superconductivity is always higher than at the second and all the succeeding ones; the value of j_c stabilizes and becomes reproducible only after the first two or three transitions of the sample to the normal state. Samples subjected to aging after prior recrystallization and after cold deformation are investigated. To explain the results, it is assumed that the sample is in the critical state and the problem of force-free current flow in a ribbon is solved. The magnetization connected with the current is also calculated. (M.H.R.)

7339 RESONANT SCATTERING IN La–Ce. Wollan, J. J.; Finnemore, D. K. (Ames Lab., Iowa). Phys. Lett.; 33A: 299-300(16 Nov 1970).

Electrical resistivity measurements from 0.060 to 20.0 indicate that the magnetic impurity scattering in La–Ce has a resonant character with a characteristic temperature of 0.17 K. (auth)

7340 SUPERHEATING, SUPERCOOLING, AND SURFACE SUPERCONDUCTIVITY OF PURE TYPE-I SUPERCONDUCTORS AND THEIR ALLOYS. Smith, Frederick William. Providence; Brown Univ. (1969). 148p. University Microfilms Order No. 70-8793.

Thesis.

The magnetic response of several pure Type-I superconductors, viz., Sn, In, Tl, Pb, and Hg was investigated with special emphasis placed on the observation of metastable (superheated and supercooled) states. The magnetic response of Type-I and Type-II superconductors in a series of Sn–In alloys was also studied as a function of electron mean free path. The possible influences of of strong electron–phonon coupling and of an anisotropic superconducting energy gap on κ_0 and $\kappa(T)$ for both pure and alloy superconductors are discussed in the light of observed experimental deviations from the predictions of the isotropic, weak-coupling BCS theory of superconductivity. (TSS) (Diss. Abstr. Int., B)

7341 SEARCH FOR ACTIVE INTERACTIONS AND MEASUREMENTS OF THE RESISTIVITY TENSOR IN SUPERCONDUCTING INDIUM. Mundy, Joseph Leagrand. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 164p. University Microfilms Order No. 70-11,328.

Thesis.

The superconducting state is evaluated as a medium for wave particle interaction leading to amplification. The pure superconducting state is shown to be unattractive on a theoretical basis. The intermediate state in indium is investigated experimentally in terms of the resistivity and Hall effect. The results are compared with the work of others and interpreted in terms of wave properties as pertains to amplification. The Hall angle in the intermediate state can be accounted for by the normal-state electron behavior in a magnetic field H_c. The behavior of the intermediate-state resistance can be accounted for by the laminar model more consistently than the flux tube model. Also, an anomalous transverse voltage is observed that reverses with magnetic field polarity but not current. This is interpreted in terms of domain orientation and is shown to play a role in helicon wave behavior in the intermediate state. (Diss. Abstr. Int., B)

7342 SUPERCONDUCTING TRANSITION TEMPERATURE OF TIN WITH THALLIUM ADMIXTURES. Sulkowski, C.; Mazur, J. (Inst. of Low Temperatures and Structural Research, Wroclaw). Acta Phys. Pol.; A38: 761-5(Nov 1970).

The influence of the thallium admixtures (concentration 0.02, 0.043, 0.12 and 0.210 at. %) was studied; from the measurements of the current transition curves, the transition temperatures T_c were estimated. The lowering of the transition temperatures is in good agreement with predictions of Anderson theory. (auth)

7343 DISTRIBUTION OF CURRENT IN THE RESISTIVE STATE OF A TYPE-II SUPERCONDUCTOR. Makiej, B.; Sikora, A., Trojnar, E. (Inst. for Low Temperatures and Structural Research, Wroclaw). Acta Phys. Pol.; A38: 449-51(Nov 1970).

The distribution of the magnetic field in a slot cut in the middle part of an $In_{94}Pb_6$ cylinder (a type-II superconductor) carrying a current was measured by means of a bismuth probe. The change of the magnetic induction along the radius of the specimen permitted the distribution of the current density to be inferred. Fluctuations of the current distribution were observed just at the transition to the resistive state. (auth)

7344 SUPERCONDUCTING TUNNELING IN SINGLE-CRYSTAL AND POLYCRYSTAL THIN FILMS OF ALUMINUM. Wells, Gene Landis. Chapel Hill, N. C.; Univ. of North Carolina (1969). 74p. University Microfilms Order No. 70-12,120.

Thesis.

A semiclassical theory of electron tunneling is developed. It is shown that superconducting tunneling measurements can be interpreted in terms of an energy gap that is effective in an 11½° cone about the normal to the tunnel junction. Comparison of the measured energy gap and transition temperature for thin films of aluminum with bulk values is discussed. Measurements of the energy gap (2Δ) and transition temperature (T_c) of aluminum films in six different types of tunnel junctions are reported. The tunnel junctions were formed by vacuum evaporation of aluminum onto KBr or quartz substrates, oxidizing the aluminum to form a tunneling barrier and evaporating either aluminum or indium as the second metal of the tunnel junction. The first evaporated aluminum film on KBr substrates was either a single crystal with [100] normal to the surface or a polycrystal with a [111] texture axis. The second evaporated aluminum film on KBr substrates was a polycrystal with a [111] texture axis. Aluminum films on quartz could not be inspected for orientation. It was found that the T_c of aluminum films was linearly dependent upon the strain caused by thermal expansion differences between the aluminum film and the substrate. This strain did not change the ratio $2\Delta/kT_c$. Measured values of 2Δ and T_c for aluminum films with indium as the second metal of the tunnel junction were found to be significantly different from the values measured for similarly prepared aluminum films with aluminum as the second member of the tunnel junction. Empirically, the effect of indium on aluminum in an aluminum/indium tunnel junction was found to be an apparent increase of T_c by 3.2% and an apparent decrease of 2Δ by 3.3%. The energy gap measured in the [100] direction in single crystal aluminum films was 3.64 kT_c. In the [111] direction, the measured value was 3.44 kT_c. This anisotropy is consistent with previous energy gap measurements on bulk single crystal aluminum. (Diss. Abstr. Int., B)

7345 ELECTRON INTERFEROMETRIC MEASUREMENT OF QUANTIZED MAGNETIC FLUX IN SUPERCONDUCTIVE HOLLOW CYLINDERS. PART II. Wahl, H. (Univ., Tuebingen, Ger.). Optik; 30: 577-89(1970). (In German).

The quantized magnetic flux in superconductor hollow cylinders was measured by two methods—one with frozen flux and one without. The superconducting hollow cylinder was placed between the partial waves so that only a part of the interferogram was affected by the frozen flux. From the band displacement the frozen flux was determined. In the interferograms thus obtained, it was observed sporadically that the frozen magnetic flux was altered over the length of the cylinder. In heating the cylinders, the width of the normalized zone was observed which was remarkable in a time displacement of the band deflection. This time variation was recorded by the second method in which a part of the interference field, stepped down by a slit, was projected on a uniform moving film. This interferogram shows that the frozen flux in the approach to the transition temperature did not disappear suddenly, but decreases continuously at a temperature interval of about 0.05°K under the transition temperature to zero. From the deflection of the interference bands the frozen flux was determined, and it is constant over the given range of the external field. From the size of the range of the external magnetic field with equal frozen magnetic flux, the change of the external flux corresponding to this range was determined. The value obtained was in agreement with theory. (tr-auth)

7346 CREEP OF INDIUM IN NORMAL AND SUPERCONDUCTING STATES. Gindin, I. A.; Lazarev, B. G.; Starodubov,

Ya. D.; Lebedev, V. P. (Physical-Technical Inst., Kharkov. Kharkov State Univ.). Fiz. Metal. Metalloved.; 29: 862-8(Apr 1970). (In Russian).

The phenomenon of strength loss in polycrystalline indium (99.9999%) associated with creep in the superconducting state, due to suppression of the retardation mechanism of partial and complete dislocations by the conduction electrons, was studied. It was found that the magnitude of the effect of strength loss depends on the effective stress and the temperature. A possible mechanism of the phenomenon is discussed. (tr-auth)

7347 INVESTIGATION OF RELATION OF SUPERCONDUCTING PROPERTIES TO THE STRUCTURE OF TITANIUM–47 WT. PERCENT NIOBIUM ALLOY. Vozilkin, V. A.; Prekul, A. F.; Rakin, V. G.; Bolkenshtein, N. V.; Buinov, N. N. (Inst. of Physics of Metals, Moscow). Fiz. Metal. Metalloved.; 26: 655-63(Oct 1968). (In Russian).

The structure was studied and critical current measurements were made on the superconducting Ti–47 wt % Nb alloy (31.4 at. %), in relation to the heat treatment and deformation. The change in superconducting properties in samples, annealed after deformation, is explained by the formation of aggregates of titanium atoms on dislocations and by their subsequent transition in the α-phase fraction. Superconducting properties in hardened and also in annealed alloys were due to the precipitation of the ω phase. (tr-auth)

7348 STRAIN-INDUCED ELECTRIC FIELDS IN SUPERCONDUCTING ALUMINUM. Goldstein, Y. (Hebrew Univ., Jerusalem); Cohen, M.; Abeles, B. Phys. Rev. Lett.; 25: 1571-5 (30 Nov 1970).

Electromagnetic waves are excited in Al/Pb superconducting tunnel junctions by compressional 9.3-GHz acoustic waves when the acoustic wave front makes a small angle with the plane of the tunnel junction. The electromagnetic waves are induced by the electrostatic field in the superconducting Al film, which is due to the compressional strain gradient in the Al. This result provides experimental confirmation of the theories of Dessler et al. and Herring developed for the case of gravitation-induced strains. (auth)

7349 SPATIAL DEPENDENCE OF A SUPERCONDUCTIVE ORDER PARAMETER WITH KONDO EFFECT. Soda, Toshio (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 44: 580-9(Sep 1970).

A spatial dependence of an order parameter around a single paramagnetic impurity in the superconductor is investigated at finite temperatures below the transition temperature, including absolute zero. The self-consistent integral equations for the order parameter are set up and solved for the order parameter at those space points, of which distance from the impurity is greater than the coherence length. The scattering t-matrices for a perturbational method and for a classical spin are used. The order parameter shows a weak long-range variation. The calculational procedure beyond this approximation, as well as the Kondo effect on the spatial variation, is discussed. (auth)

7350 OPTICAL PROPERTIES OF NIOBIUM–TITANIUM SUPERCONDUCTING ALLOYS. Leksina, I. E.; Motulevich, G. P.; Shubin, A. A.; (and others) (Lebedev Inst. of Physics, Moscow). Fiz. Metal. Metalloved.; 29: 97-107(Jan 1970). (In Russian).

The optical constants n and χ were measured in the spectral region 1 to 10 μ at room temperature for electropolished cubic β solutions of Nb–Ti of the following concentrations: 25, 40, 52, 70, and 85 at. % Nb. On the same alloy samples the density, the static conductivity, the resistance at room and liquid nitrogen temperatures, the residual resistance, and the superconducting transition temperature T_c were determined. According to the data obtained, values were determined for the fundamental properties of the conduction electrons of the alloys investigated (the conduction electron concentration N, their average velocity v_F on the Fermi surface, complete area of the Fermi surface S_F, the effective collision frequency of the electrons ν, the collision frequencies of electrons with phonons ν_{ep}, and collision frequencies of electrons with impurities ν_{ed}). An attempt was made to establish the correlation of N and ν_{ep} with T_c for the Nb–Ti alloy. (tr-auth)

Equipment and Devices

Refer also to abstract 7415.

7351 (IPP–4/79) EFFECT OF FAST-PULSED MAGNETIC FIELDS ON SINGLE-LAYER SUPERCONDUCTING COILS. Martinelli, A. P. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb 1969. 10p. Dep. NTIS (U. S. Sales Only).

Pulsed fields (rise time ≈ 7 μsec, $dH/dt = 10^7$ to 10^9 Oe/sec) were applied to small single-layer coils (Nb–25 % Zr, Nb–48 % Ti) short-circuited by a low-resistance shunt, with transport current I_t and superposed background field. Within the experimental error, I_t and the current I_p induced in the sample by a pulse just large enough to cause field penetration add up to the statically determined critical current I_c of the sample. (auth)

7352 (UCRL–72330) STABILITY IN SUPERCONDUCTING MAGNETS. Henning, C. D. (California Univ., Livermore. Lawrence Radiation Lab.). 20 May 1970. 7p. (CONF-700912–8). Dep. NTIS.

From 5th Annual Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev.

The newest stabilization techniques are reviewed, including nucleate cooling, multifilamentation, twisting, and enthalpy stabilization. A discussion is presented of which techniques are suitable for a given application. (M.H.R.)

7353 (UCSD–34–P-143-29) LIQUID ^{3}He, LIQUID MIXTURES OF ^{3}He AND ^{4}He, AND DILUTION REFRIGERATION. Wheatley, John C. (California Univ., La Jolla, San Diego. Dept. of Physics). [1970]. Contract AT(04-3)-34. 38p. Dep. NTIS.

Basic properties of pure liquid ^{3}He and of dilute solutions of ^{3}He in superfluid ^{4}He are reviewed as they relate to the design and operation of dilution refrigerators. Brief discussions are given both of the intrinsic limitations of the dilution refrigerator and of instabilities that can degrade performance. Finally, some characteristics of a new generation of practical dilution refrigerators are displayed and discussed. (auth)

7354 ^{3}He–^{4}He DILUTION REFRIGERATOR FOR NUCLEAR ORIENTATION EXPERIMENTS AT THE HARWELL ELECTRON LINEAR ACCELERATOR. Postma, H. (Atomic Energy Research Establishment, Harwell, Eng. Kamerlingh Onnes Laboratorium, Leiden). Nucl. Instrum. Methods; 88: 45-50(1970).

A cryostat based on the ^{3}He–^{4}He dilution principle, which is able to cool large samples to 0.05 K and lower, is described. This cryostat is particularly designed for long term nuclear orientation experiments with wide beams of neutrons. A cooling rate of 300 to 500 erg/s was obtained at 0.1 K with a ^{3}He circulation of about 7×10^{-5} mole/s. (auth)

7355 EXPERIMENTAL AND THEORETICAL STUDIES OF FILAMENTARY SUPERCONDUCTING COMPOSITES. J. Phys., D (London); 3: 1517-85(Nov 1970).

A detailed study was made of the properties of twisted filamentary superconducting composites. It is shown that such conductors can be used to construct high-current-density superconducting coils that will reach their full critical current without the necessity for additional stabilization. In addition, such composites can be designed to have a sufficiently low ac loss for slow ac or pulsed applications. (auth) (UK)

Plasma and Thermonuclear Physics

7356 (IPPJ–97) PRODUCTION OF ION STREAM COMPOSED OF TWO COMPONENTS IN VELOCITY DISTRIBUTION. Honzawa, Tadao (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1970. 13p. Dep. NTIS (U. S. Sales Only).

A new type source of ion stream composed of two components in energy distribution is investigated. A diffusion-type plasma source is used, which is formed with two arrays of oxide-coated cathode rods and five sheets of metallic mesh grids. The energy distribution of ion stream is observed with an electrostatic energy analyzer, whose resolution is 4%. Ion streams of argon, helium, nitrogen and their mixtures are obtained, the energy of which ranges from 50 to 500 eV. The energies of two components of ion stream are determined by the biases externally applied to two pairs of grids, and their relative intensities can be controlled by adjusting the temperature of the fore array of cathode rods and/or the potential of the intermediate grid. (auth) (Japan)

Confinement and Heating

Refer also to abstracts 7391, 7395, and 7410.

7357 (LA-tr-70-23) ONE RULE OF DIFFUSION OF A PLASMA IN STELLARATORS. Shpigel', I. S. Translated by

Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report FIPNL-32. 11p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 32808. (M.O.W.)

7358 BEHAVIOR OF rf-HEATED PLASMAS IN A TOROIDAL OCTUPOLE MAGNETIC FIELD. Sprott, Julien Clinton. Madison, Wis.; Univ. of Wisconsin (1969). 157p. University Microfilms Order No. 69-22,485.

Thesis.

Microwave frequencies of 700 to 9000 MHz and powers up to 100 kW were used to produce and heat plasmas in regions of electron cyclotron resonance in a toroidal octupole magnetic field. A theoretical model was developed to predict the heating rate of a cold tenuous plasma in an arbitrary nonuniform magnetic field. The model predicts strong heating at places where $\nabla_{||} B = 0$ at resonance. The heating is most efficient when the density is such that the microwave frequency ω lies in the range $\omega_p^2 < \omega^2 < \omega_p^2 Q$, where ω_p is the plasma frequency and Q is the quality factor of the cavity. Two types of experiments were performed. In one type, a gun-injected plasma with $n \sim 10^9$ cm^{-3}, $kT_e \sim 5$ eV, and $kT_i \sim 40$ eV is heated by a pulse of microwaves with $p \sim 10^{-6}$ torr. Scintillator probes show the predicted localized heating, and indicate that the electron distribution during the heating is non-Maxwellian with an average energy of 100 eV to 1 keV. After the heating pulse, the energetic electrons are rapidly lost to obstacles in the plasma, so that after ~100 μsec, the average energy returns to near its original value. The other type of experiment consists of raising the background gas pressure to $\sim 10^{-4}$ torr and breaking down the gas by microwaves without preionization. The resulting plasma in the afterglow has $n \sim 10^9$ to 10^{11} cm^{-3}, and $kT_i < kT_e \sim 1$ eV. The spatial distribution is a strong function of the position of the resonance zones. Langmuir probe measurements show a temperature decay in agreement with calculations for inelastic electron–neutral collisions. The particle life-time is ~3 msec, and most (~80%) of the plasma is lost to the hoops. Several classes of fluctuations were studied, but it does not appear that they are an important source of plasma loss. The heating model was extended to include ion cyclotron heating, and it is shown that the heating rate for ions is the same as for electrons if the electric field has the same strength and if the resonance zones occur in the same places. For low-density plasmas ($n \sim 10^9$ cm^{-3}) it is shown that low-frequency electric fields can penetrate the plasma and that appreciable ion heating should result. (Diss. Abstr. Int., B)

7359 EXCITATION OF ION CYCLOTRON WAVES IN A PLASMA IN A TOROIDAL MAGNETIC TRAP. Ovchinnikov, S. S.; Kalinichenko, S. S.; Shvets, O. M.; Tolok, V. T. JETP Lett. (USSR) (Engl. Transl.); 12: 187-9(20 Sep 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 277-80(20 Sep 1970).

An investigation is reported of wave excitation in a plasma situated in a toroidal magnetic field (without a linear section) with the aid of exciting elements introduced inside the chamber and located near the plasma boundary. The solution of this problem allows one to approach a study of hf methods for heating a dense plasma in a system with a toroidal field, particularly, by means of stochastic external irregular fields. The experiments demonstrated effective heating by wave-excitation mechanisms. (M.O.W.)

7360 PHENOMENA OF DRIFT IN WEAKLY IONIZED TURBULENT PLASMA IN THE ABSENCE OF AN EXTERNAL MAGNETIC FIELD. Baimbetov, F. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 48-58(Mar-Apr 1968). (In Russian).

The influence of low-frequency plasma oscillations (turbulences) on drift phenomena in weakly ionized plasma was studied by means of the Chapman–Cowling method. Charged-particle collisions contributing to the low degree of ionization are neglected. Expressions are obtained for thermal flux, force of friction, and viscosity tensors, considering interactions of electrons with oscillations. From expressions derived it follows that near $\nu_{ew} = (2/3)(\alpha^2_{Le}/\nu_{en})(|E|^2/8\pi n_e T_e)$, the order of frequency of electron–neutral collisions ν_{en}, oscillations significantly affect the drift phenomena. (tr-auth)

7361 NEW DIFFUSION MECHANISMS IN A TOROIDAL PLASMA. Haines, M. G. (Imperial Coll. of Science and Tech., London). Phys. Rev. Lett.; 25: 1480-3(23 Nov 1970).

A two-fluid model of a toroidal axisymmetric plasma is employed to examine the resistive diffusion in a Tokamak configuration. The self-consistent magnetic field resulting from all plasma currents is included, and the time-dependent rotation computed. Several new terms, additional to the Pfirsch–Schluter diffusion, arise. Of these, one depends on the shear in the magnetic lines of force, and another on the outward displacement of the plasma constant-density surfaces relative to the magnetic surfaces. (auth)

7362 INEXPENSIVE, FAST ON–OFF, HIGH POWER, PULSED rf AMPLIFIER. Melton, R. D.; Cato, J. E.; Kristiansen, M.; Hagler, M. O. (Texas Tech Univ., Lubbock). Rev. Sci. Instrum.; 41: 1903-4(Dec 1970).

An inexpensive power amplifier was designed and constructed for rf plasma heating studies with the following specifications: (1) 50 μsec to >1 msec pulsed output over the frequency range 4 to 6 MHz, (2) power output of over 150 kW, and (3) rf envelope rise- and fall-times of approximately 3 and 5 μsec, respectively. The short rise- and fall-times were achieved through the use of gas-filled triggered spark gaps, which is the main unique feature of this amplifier. (M.O.W.)

Diagnostics

7363 (CLM-R-104) ON-LINE DATA ACQUISITION SYSTEM USING A LINC-8 COMPUTER. Murphy, E. G.; Steed, C. A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). May 1970. 33p. Dep. NTIS (U. S. Sales Only). UK 4s. 6p.

The hardware and software of an on-line data acquisition system used on a plasma physics experiment are described. The purpose of the system is to sample analog signals under program control, file the data on magnetic tape, perform routine computations on that data, print out the results, and display the raw data in an easily assimilable form on an oscilloscope. The programs are designed to provide a flexible system and, by making programs fully interactive where necessary, to be used by people with no knowledge of computers. (auth)

7364 (COO-1726-54) PLASMA MEASUREMENTS IN A LEVITATED PULSED OCTUPOLE. Forsen, H. K.; Kerst, D. W.; Breun, R. A.; Cavallo, A. J.; Drake, J. R.; Sprott, J. C. (Wisconsin Univ., Madison. Physical Sciences Lab.). Jun 1970. 4p. (CONF-700817-25). Dep. NTIS.

From 4th European Conference on Controlled Fusion and Plasma Physics, Rome, Italy.

Studies with levitated hoops in a pulsed toroidal octupole were undertaken with gun-injected and microwave-produced plasmas. Density decay rates were less than Bohm and were less with levitated hoops than with supported hoops. (auth)

7365 (IPP-1/109) VELOCITY DISTRIBUTION OF ANISOTROPIC DEUTERIUM PLASMAS FROM TIME RESOLVED NEUTRON SPECTRA. Neuhauser, J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1970. 58p. (In German). Dep. NTIS (U. S. Sales Only).

The ion energy in hot deuterium plasmas can be determined by using the Doppler broadening of the d–d neutron line at 2.45 MeV. A method allowing time resolved measurement of neutron spectra in pulsed discharges is described. It utilizes the known energy dependence of the total neutron cross section of light to medium nuclei for energy selection of the neutrons. The neutrons are detected with plastic scintillators which afford both a high detection probability and a time resolution in the nanosecond range. The method is applied to a theta pinch for investigating the anisotropy and relaxation of the deuteron velocity distribution. It is shown that, in particular, the ion energy parallel to the magnetic field can readily be measured even at the low neutron yield available at present. Suitable combination of this procedure with known diagnostic methods allows deviations of the velocity distribution from the isotropic Maxwell distribution to be determined with sufficient accuracy. Comparison of the experimental relaxation rate with the theoretically predicted collision relaxation shows that Coulomb collisions are not a sufficient explanation. The short-wave mirror instabilities also observed probably make a major contribution to the relaxation of the anisotropic velocity distribution. (auth)

7366 (IPPJ-96) EXPERIMENTAL INVESTIGATION OF A SLOW THETA PINCH PLASMA (BSG I'). Hayase, Kiyoshi; Okuda, Takayoshi (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1970. 37p. Dep. NTIS (U. S. Sales Only).

Various properties and behaviors of a plasma in a slow theta-pinch (BSG I') are measured and investigated in detail. Basic parameters such as the temperature and density are measured in a wide pressure range by laser scattering and interferometry. The characteristics of the temperature and the compression time are compared with a snow plow model, and they are in good consistency. The instability appears at the pressure higher than 50 mtorr but is suppressed at the pressure higher than 350 mtorr. Some discussions about the stabilization effects are described. The end loss is also measured and the e-folding time is more than 20 μs. To produce a plasma of low density, z-discharge

preionization is applied, and the slow theta-pinch is operated in the first half cycle. A new method is applied to initiate the z-discharge even at very low pressure. This allows one to investigate a collisionless plasma in a theta-pinch, in which some anomalies on the contraction and heating are observed. (auth) (Japan)

7367 PLASMA PARAMETERS BY rf CONDUCTIVITY MEASUREMENTS. Chiplonkar, V. T.; Shah, R. G. (Inst. of Science, Bombay). Indian J. Pure Appl. Phys.; 6: 128-9(Mar 1968).

Particle density and collision frequency for a low-temperature diffusion-controlled plasma were measured by determining the rf conductivity and checked by a Langmuir single probe. Consistent results were obtained. (auth)

7368 RADIAL DISTRIBUTIONS OF MAIN CHARACTERISTICS OF PLASMA IN COLUMN OF FREE-BURNING ELECTRIC ARC. Krinberg, I. A.; Smirnova, E. V. (Inst. of Geochemistry, Irkutsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 13, Ser. Tekh. Nauk; No. 3, 8-15(1968). (In Russian).

Using simplifying assumptions, formulas are deduced for the radial temperature distribution T(r), electron density $N_e(r)$, and the radial component of the electric field strength $E_r(r)$ in a free-burning electric arc column. Relations containing the minimum parameters (and having some physical sense) are: $T(r) = T_0[1 - (1/2)(r^2/R^2)]$, $N_e(r) = A(N_{e0}/A)^{T_0/T_r}$, and $E_r(r) = (kT_0/eR) \ln (A/N_{e0})(r/R)[1 + (1/2)(r^2/R^2)]$, where T_0 and N_{e0} are the values electron temperature and electron concentration along the axis of the arc; R = r near $T = T_0/2$; $A = 10^{20}$. Comparison of the calculated and experimental distributions shows the formula T(r) accurate with error not more than 5 to 10%, formula $N_e(r)$ with error 20 to 100%, and in the case of $E_r(r)$ a regular change of E on changes of T_0 and N_{e0} is indicated. (tr-auth)

7369 MECHANISM FOR DETERMINING THE ELECTRON ENERGY DISTRIBUTION FUNCTION IN PLASMA OF NEGATIVE LUMINESCENCE GLOW DISCHARGE. Solntsev, G. S.; Orlov, A. I.; Dovzhenko, V. A. Radiotekh. Elektron.; 15: 1980-2(Sep 1970). (In Russian).

Electron energy distribution functions were obtained for negative luminescence plasma of abnormally dense, glowing helium (0.8 to 1.5 mm Hg), neon (0.5 mm Hg), and argon (0.12 mm Hg) discharges with the current ranging from 600 to 1000 μA. The analysis was confined mainly to slow electrons, which comprise mainly the electron mass of negative luminescence plasma. Tabulated data show that, under various conditions in various gases, as a rule $\eta > 1$, and the basic mass of plasma electrons has a Maxwell energy distribution, which is in good agreement with the experimental data. (R.V.J.)

7370 ELECTRON DISTRIBUTION FUNCTION IN A KNUDSEN-DISCHARGE PLASMA IN ARGON. Byrdin, Yu. A.; Byrdina, T. G.; Karetnikov, D. V. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 235-9(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 246-51(Mar-Apr 1970).

The plasma parameters and the electron distribution function in the plasma of a Knudsen arc in argon have been measured by a double electronic differentiation of the probe signal. The plasma contains more fast electrons than in a Maxwellian distribution. The existence of an anisotropic distribution of electrons with energies exceeding the cathode barrier implies a strong interaction of the electron beam with plasma oscillations. This interaction may occur in thermionic converters operating in the arc mode. (auth)

7371 EXPERIMENTAL INVESTIGATION OF THE ELECTRICAL CONDUCTIVITY OF A He–K PLASMA. Batenin, V. M.; Chinnov, V. F. (Inst. of High Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 412-13(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 441-2(Mar-Apr 1970).

Measurements were made on a dc arc discharge in He containing 0.6 to 4×10^{-2}% K. The experimental K_0 values agree well with calculated values; the kinetic coefficient is 1.2 for $p = \nu_{ei}/\nu_{ea} = 0.01$ to 0.1. (D.L.C.)

7372 INTERFEROMETRIC METHOD FOR DIRECT DETERMINATION OF THE DENSITY DISTRIBUTION OF ELECTRONS IN THE VOLUME OF A PLASMA. Belan, N. V.; Pimkin, V. A.; Skibenko, A. I.; Zinov'ev, V. V. (Kharkov Aviation Inst.). High Temp. (USSR) (Engl. Transl.); 8: 340-5(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 367-73(Mar-Apr 1970).

The possibility of determining the distribution of electron density over a cross section of the discharge is demonstrated, using an interferometric method. An analysis is made of possible errors in determination of the phase increment in the measurement sections for phase meters with a given sensitivity and for several kinds of density distribution of the electrons. (auth)

7373 MEASUREMENT OF THE ELECTRON TEMPERATURE OF A PLASMA USING A DIFFERENTIAL ANALYZER OF CHARGED PARTICLES WITH RESPECT TO THE ENERGY. I. BASIS OF METHOD. Alinovskii, N. I.; Nesterikhin, Yu. E.; Rogozin, A. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). High Temp. (USSR) (Engl. Transl.); 8: 333-9(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 359-66(Mar-Apr 1970).

The construction of a differential analyzer of electrons with respect to energy is described, and the basis of a method for measuring the electron temperature of a plasma using the instrument is given. Possible distortions of the electron energy spectrum, introduced during the measurement process, are analyzed. (auth)

7374 APPARATUS FOR THE MEASUREMENT OF HIGH TEMPERATURE PLASMA REACTIONS. Mullen, J. H.; Madson, J. M.; Medgyesi-Mitschang, L. N.; Peng, T. C.; Doane, P. M. (McDonnell Douglas Corp., St. Louis). Rev. Sci. Instrum.; 41: 1746-54(Dec 1970).

An experimental apparatus designed for studying reaction processes in high-temperature plasmas is described. An rf induction plasma produced at gas temperatures from 1000 to 4000 K is passed through a reaction channel at sonic velocity where it reacts with supersonically injected target gas molecules. Pressures in the reaction channel can be varied from 25 to 125 torr. The plasma, together with the reaction products, undergoes a free jet expansion into a vacuum chamber at 0.2 torr where the expansion core flow is sampled by a molecular beam mass sampling system using a quadrupole mass spectrometer for analysis. The electron density in the free jet is measured with a Ka-band interferometer. The electron temperature in the plasma source and reaction channel is measured spectroscopically; in addition, the electron temperature in the source is monitored with an X-band radiometer. The change in the electron density, together with the change in the intensity of the positive and negative ion signals as a function of the number of target gas molecules injected, is used to evaluate the reaction rates. Examples of electron attachment rate measurements in N_2O–Ar and SF_6–Ar mixtures at 3000 K are given. (auth)

Kinetics (General)

Refer also to abstracts 7016, 7274, and 7401.

7375 (BMBW-FBK-70-17) INVESTIGATIONS ON LOW-INDUCTIVE SPARK GAPS FOR HIGH VOLTAGES IN AIR. Pillsticker, M. (Technische Universitaet, Brunswick (West Germany). Institut fuer Hochspannungstechnik). Oct 1970. 44p. (In German). Dep. NTIS (U. S. Sales Only).

Investigations on the development of a low-inductive spark gap (smaller than 10 nH) are reported. The time between the start of trigger pulse and the complete breakdown, as well as the jitter of this time, should not exceed a few nanoseconds. The operating voltages are substantially lower than the static breakdown voltage in excess of 100 kV. The most important parameters for such short times are: energy of the trigger pulse, geometric dimensions of the electrodes, gas pressure in the spark gap, and the voltage across the main electrodes before applying the high-voltage trigger pulse. The investigations revealed that a four-electrode spark gap is the best choice to meet the requirements. (auth)

7376 (IPP-2/87) INVESTIGATIONS AT THE ION-BEAM INJECTION SYSTEM ISIS I USING A DUOPLASMATRON WITH ELECTRON OSCILLATION IN THE ANODE PLASMA. Ulbricht, Peter (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr 1970. 29p. (In German). Dep. NTIS (U. S. Sales Only).

Investigations were made to find suitable conditions for the injection of an ion beam that has small divergence, high intensity, and Gaussian density distribution. It is shown that the only parameters that influence the beam are those acting at the plasma boundary. These are the parameters of the ion source that determine the emission, and also the extraction field strength and the shape of the extraction field. A modified four-electrode duoplasmatron, with electron oscillation in the anode plasma, was used as an ion source. With this type of source, a favorable relation between arc current and emission current was obtained. The space-charge forces of the plasma boundary could be decreased by means of a plasma expansion cup. Furthermore, the different influences of the deceleration–acceleration system on

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the beam were investigated. The mass analysis of the beam showed that this type of ion source delivers up to 50% H_3^+ ions for arc currents in the range 1 to 7 A. A high portion of metastable ions were observed. (auth)

7377 THERMODYNAMICS OF A STRONGLY NONIDEAL PLASMA. Norman, G. E.; Starostin, A. N. (Inst. of High Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 381-408(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 413-38(Mar-Apr 1970).

This review is an attempt to systematize critically the information on the thermodynamics of a strongly nonideal plasma (at the present time not always settled and reliable), to compare the results of various work, and to evaluate the validity of the approximations used. The main emphasis is laid on low-temperature plasma (10^3 to 10^5°C). Section 1 discusses the simplest model approach to the study of systems of Coulomb particles with strong interaction. Section 2 considers the general form of the thermodynamic quantities, following from the homogeneity of the Coulomb potential in classical and quantum statistics. The information required from the theory of a weakly nonideal plasma is set forth in Section 3. Section 4 considers thermodynamic inequalities in a plasma; attention is paid to perturbations which are both fast and slow in comparison with the ionization relaxation time; a study was made of thermal and mechanical stability and of the stability with respect to diffusion. Section 5 considers the role of quantum effects in the interaction of free charges, ensuring the thermodynamic stability of a strongly nonideal nondegenerate plasma. Section 6 is devoted to the equation of state: it analyzes the possibility of the stratification of a dense plasma into phases, discusses the form of the phase diagrams, the existence of critical points and the possibility of the existence of supercooled metastable states of a dense plasma. Machine experiments (the Monte Carlo and molecular dynamics methods) for the investigation of strongly interacting Coulomb systems and of a nonideal plasma are considered in Section 7. Regions of applicability of various approximations and calculating methods in the theory of a dense plasma are discussed in Section 8. Section 9 considers the few existing results of experimental investigations of the equation of state of a strongly nonideal plasma. 108 references. (auth)

7378 EFFECT OF IONIZATION ON HEAT TRANSFER TO WIRES IMMERSED IN AN ARC PLASMA. Petrie, Thomas Walter. Minneapolis; Univ. of Minnesota (1969). 221p. University Microfilms Order No. 70-15,790.

Thesis.

The local heat transfer to a solid body immersed in a highly ionized gas in local thermodynamic equilibrium (LTE) is measured by sweeping wire probes through the plasma of a high-intensity, free-burning arc in argon at atmospheric pressure. Heating of the wire material used increases its electrical resistivity. This, in turn, results in an increased voltage drop across a wire when a constant current passes through a fixed length of it. As a wire is swept through the plasma, this voltage drop indicates the heat transferred to the entire wire. The history of the voltage drop across the wire is recorded with an oscillograph as a function of the wire's position in the plasma and forms the raw experimental data. Theoretical estimates are made of the steady-state heat flux to the wire for various assumptions of the heat-transfer mechanisms. The experimental heat fluxes, extrapolated to zero sweeping rate, agree well with the theory for a frozen boundary layer. The data correlate in terms of parameters used in the frozen theory allowing an estimation of the heat transfer in the general situation of a solid body immersed in a highly ionized gas in LTE. Furthermore, additional experiments show that the sweeping wire is sensitive to nonequilibrium plasma conditions. (TSS) (Diss. Abstr. Int., B)

Kinetics (Experimental)

7379 (IPP-4/72) INVESTIGATION OF THE EROSION PHENOMENON IN HIGH CURRENT, HIGH PRESSURE GAS DISCHARGES. Gruber, J. E.; Suess, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec 1969. 31p. Dep. NTIS (U. S. Sales Only).

The erosion measured as the loss of electrode material was determined in different spark gaps with plane parallel electrodes. In the range from 50 to 300 kA and a corresponding total current conduction between 1 and 50 Coulomb per discharge, the erosion in a 1.5-mm gap was found to be nearly two orders of magnitude higher than in a 13-mm gap at atmospheric pressure. The close electrode spacing was found to be responsible for the increased erosion rather than the gas pressure. Erosion values for an oscillatory current are given for aluminum, brass, stainless steel, molybdenum, tungsten, and tungsten–copper alloys. (auth)

7380 (MATT-Trans-102) SKIN-EFFECT IN POWERFUL Z-DISCHARGES. Dubovoi, L. V.; Fedyakov, V. P.; Fedyakova, V. P. Translation of Russian Preprint T-0107. 26p. Dep. NTIS.

Experiments with pulsed z discharges characterized by anomalous plasma conductivity in the skin layer region are discussed. It is demonstrated that the characteristic features of behavior of powerful direct discharges, in particular, fast z-pinches, agree with the hypothesis of probable excitation of ion–acoustic microinstability in the current layer of the discharges. (auth)

7381 (NP-18532) STARK EFFECT IN A TURBULENT PLASMA OF R.F. DISCHARGE IN "OMEGA" DEVICE. Berezin, A. B.; Dubovoi, L. V.; Lublin, B. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 7p. Dep. NTIS (U. S. Sales Only).

Profile measurements were made of H_α, H_β, and H_γ spectral lines in a plasma of a powerful hf discharge. In those conditions, when ion sound instability takes place, abnormally large broadening of H_β and H_γ lines is found for measurements in a perpendicular direction to discharge field. The strength of a longitudinal component of the microturbulence field $\tilde{E}_{\|eff}$ is evaluated. In experiments with $E_\| \lesssim 1$ keV/cm, strong anisotropy of the turbulence field, corresponding to $E_\| \gg E_\perp$ is found. (auth)

7382 (NP-18539) ACCELERATION OF A PLASMA BY A MOVING CURRENT LAYER. Jourdan, Philippe (Paris Univ., Orsay (France)). 1970. 99p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The structure of a current layer induced in a theta pinch was experimentally studied. The following phenomenon was revealed: the gas encountered by the shell in its radial motion is ionized before being set into motion. The plasma crossing the current layer is accelerated up to a velocity approaching that of the layer. Inside the layer, the ions are in the A III ionization state (the state in which the atom has lost two electrons) and are subjected to an adiabatic compression, while the electrons receive thermal energy. For the two electrons liberated, this energy is approximately equal to the kinetic energy of an ion with the velocity of the current layer. This energy transfer is the result of the resistive diffusion of the plasma through the magnetic field and results from the classical resistivity due to Coulombian electron–ion collisions. However, the thermal energy thus received by the electrons is lost in inelastic collisions with plasma ions, and because of the particular nature of the gas, is finally lost by radiation. The result is an accumulation of plasma behind the current layer. This plasma progresses at the same time as the layer toward the axis of configuration. The phenomenon may be considered to be a shock wave perpendicular to a magnetic field and controlled by the resistivity. It is to be noted that the energy liberated by the slow-down of the plasma is radiated and does not appear as stored thermal energy. The structure of the shock wave is thus modified and, in particular, may exist without an initial magnetic field. (France)

7383 QUASI-STEADY PLASMA ACCELERATION. Clark, Kenn Edward. Princeton, N. J.; Princeton Univ. (1969). 192p. University Microfilms Order No. 70-11,942.

Thesis.

A steady-state acceleration phase was shown to occur in a coaxial electrode geometry during the synchronized application of tailored pulses of mass flow and current. This diffuse discharge form, characterized by a stabilized current distribution, constant voltage and current, and a steady argon mass flow rate of up to 50 g/sec, is of considerable interest as both a pulsed thruster and as a simulator of the self-field MPD arcjet over a power range from 100 kW to 100 MW. Terminal voltage measurements, taken over a wide range of power and mass flow rate, are sufficiently precise to allow discrimination among several theoretical models of the acceleration process. Kerr-cell photographs and experimental maps of the current distribution in the exhaust plume and interelectrode region clearly show the rapid transition to this steady configuration, as well as characteristic arc behavior for mass starvation and mass overfeed. (Diss. Abstr. Int., B)

7384 SPECTRUM OF MPD ARC OSCILLATIONS AT LOW-MAGNETIC FIELD. Connolly, D. J. (Lewis Research Center, Cleveland). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 2086-8(Nov 1970).

A typical sequence of arc current spectra in the MPD thruster is given. The spectrum of oscillations from 0 to 2.5 MHz in magnetic fields ranging from 0.025 to 0.05T is studied. (M.O.W.)

7385 VOLT–AMPERE CHARACTERISTICS OF ARGON PLASMA BEHIND A SHOCK WAVE IN THE PRESENCE OF COLD ELECTRODES IN A NONSELF-MAINTAINING DISCHARGE.

Maksimov, A. M.; Nikuev, Yu. A. (Inst. of High Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 257-60(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 272-6(Mar-Apr 1970).

Results are given of experimental investigations of the volt–ampere characteristics of argon plasma behind the front of a shock wave which were obtained by means of a double probe under conditions of a nonstationary boundary layer. These characteristics were used in a nonself-maintaining profile of electrons behind the front of the shock wave. The results obtained were compared with measurements of n_e carried out by means of a microwave line. The experimental values of the saturation current were in good agreement with theory. The electron concentrations for which the nonself-maintaining discharge goes over into an arc mode were also measured. (auth)

7386 EXPERIMENTAL STUDY OF NONEQUILIBRIUM PLASMA. Malikov, M. M. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 247-51(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 260-5(Mar-Apr 1970).

The results of an experimental study of the nonequilibrium plasma arising from a pulse discharge in crossed electric and magnetic fields are presented. The discharge was imposed upon a supersonic flow of argon containing traces of sodium in a channel with sectioned electrodes. In the magnetic field, the plasma was characterized by an array of inhomogeneities drawn out along the median current. The critical plasma parameters corresponding to the appearance and disappearance of this structure were determined experimentally. (auth)

7387 DETERMINATION OF HIGH-PRESSURE, HIGH-TEMPERATURE URANIUM PLASMA PROPERTIES. Randol III, Arthur G. Gainesville, Fla.; Univ. of Florida (1969). 201p. University Microfilms Order No. 70-14,913.

Thesis.

An experiment is devised and constructed to study the properties of a high-pressure uranium plasma. The plasma is generated in the column of a dc electric arc. Electrical power input to the arc ranges between 0.3 kW. Helium is the cover gas and provides operating pressures between 1.0 and 11.6 atm. An analytical study of the effects of pressure and temperature on the plasma intensity profile is made. From the results of this study, correction criteria for Boltzmann–plot temperature determinations are developed. Predictions of uranium number densities from considerations of anode vaporization are made. Temperature diagnostics are performed with the Boltzmann-plot technique. Temperatures between approximately 7,500°K (1.0 atm) and 11,500°K (11.6 atm) are determined. Arc-temperature profiles are also determined with this technique. Two methods for number density diagnostics are used. One is an absolute intensity method using photoelectric detection and a signal averager for data acquisition. The other is a correlation between the Boltzmann-plot temperature profiles and temperature profiles computed with the single-line, relative-intensity method. Number densities suggesting a maximum uranium partial pressure of 0.1 atm are deduced. The voltage–current characteristics of the arc are related to current, electrode separation, and pressure through an empirical model. A parameter derived from the empirical model is related to the uranium anode boiling temperature. These temperatures range from 3,837°K at 1.0 atm to 4.847°K at 6.86 atm. (Diss. Abstr. Int., B)

Kinetics (Theoretical)

7388 CURVILINEAR POLYADIC MOMENTS OF THE BOLTZMANN EQUATION. I. POLYADIC HIERARCHY FOR AN N-SPECIES, DILUTE, POINT PLASMA. Hawkins, Lawrence Carl (Univ. of Miami, Coral Gables, Fla.). Ann. Phys. (N. Y.); 58: 157-75(May 1970).

The Maxwell transport equation is rederived, using a general curvilinear polyadic moment $S(r,v,t)$ of the Boltzmann equation. When this moment is specified in turn to be the velocity polyads $S = m, mv, mvv, \ldots, mvv\ldots v$, the coupled hierarchy of velocity moments for an N species, dilute, point plasma is thereby obtained. For suitable choices of S and proper polyadic contractions, all of the dilute, point-plasma transport equations can be derived. Explicit results include: (1) The polyadic transport equation, with arbitrary acceleration a, for the l-th order poly-pressure $\Gamma_l = \rho\langle vvv\ldots v\rangle(l$ terms). (2) The first seven moment transport equations, for both arbitrary acceleration a and electromagnetic acceleration $\tilde{q}(E + v \times B)$, governing the flow of mass density ρ, continuum velocity V, energy density e, heat flux vector q, pressure tensor P, heat flux tensor Q, and moment of momentum $r \times mV$. Included, also, is a brief outline of future papers in this series and an appendix summarizing the curvilinear polyadic calculus used throughout the series. (auth)

7389 PENETRATION OF NEUTRAL ATOMS INTO A CYLINDRICAL PLASMA PINCH. Isaenko, L. F.; Maiorov, L. V.; Shcheglov, D. A. JETP Lett. (USSR) (Engl. Transl.); 12: 217-18(20 Sep 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 320-3(20 Sep 1970).

A Monte Carlo calculation was made of the distribution of the plasma concentration over the plasma cross section, the albedo of the plasma relative to the incident atoms, and the energy spectrum of the atoms escaping the plasma when undergoing the penetration of neutral atoms in cylindrical geometries. The results are compared with the approximate analytic solution and with the experimental data obtained in investigations of several regimes of the T-3 installation. (M.O.W.)

7390 DEVELOPMENT OF A MODIFIED CHAPMAN–ENSKOG SOLUTION OF THE LENARD–BALESCU EQUATION FOR FULLY IONIZED TWO-TEMPERATURE PLASMAS. Walters, Wallace Franklin. Albuquerque, N. Mex.; Univ. of New Mexico (1969). 81p. University Microfilms Order No. 70-12,907.

Thesis.

The Lenard–Balescu equation, the interaction integral of which includes the influence of long-range collective effects, is utilized to determine the characteristic transfer frequencies associated with a tenuous "test-particle" stream interacting with a two-temperature Maxwellian hydrogen plasma. Like-particle energy and momentum transfer frequencies, and unlike-particle energy and momentum transfer frequencies are determined for the range of T_e/T_i from 1 to 100. On comparison with the results of other investigators, the electron–electron transfer frequencies are observed to include long-range collective corrections ranging up to 40%. These large collective corrections made evident the necessity of employing the Lenard–Balescu kinetic equation to describe the behavior of two-temperature fully ionized plasmas. The "test-particle" frequencies are accepted, for ordering purposes, as being good representations of the corresponding frequencies associated with the various Lenard–Balescu interaction integrals. The ordered equation results make evident the appropriateness of the ordering parameter $\epsilon = (m_e/m_i)^{\frac{1}{4}}$ for these systems (using this parameter an energy decoupling results which is, of course, consistent with physical reality). Utilizing this ordering parameter, a modification of the "classical" Chapman–Enskog method of solution is systematically developed. This method of solution is sufficiently general that it is applicable to all stable fully ionized plasma systems of small mass ratio. The formal solutions obtained are found to be surprisingly simple, and a brief discussion is given on the determination of physical properties of interest from these solutions. (Diss. Abstr. Int., B)

7391 NONLINEAR PROBLEMS IN THE MANY-BODY THEORY OF TURBULENT PLASMAS. Ogunlana, Jide. San Diego, La Jolla, Calif.; Univ. of California (1969). 214p. University Microfilms Order No. 70-11,949.

Thesis.

The problem of turbulent many-body systems is formulated in terms of a generalized phase space, using the concepts of field theory. Utilizing this notion, a stochastic theory approach is used to formulate the problem of plasma heating by random fields. One of the main advantages of this method is that it is constructed to handle the effect of arbitrary accelerating fields on the plasma, in contradistinction to previous works in which one of the crucial assumptions is that each plasma particle independently encounters a different member of the electric field ensemble. This assumption alone renders these previous works valid only for single-particle acceleration. Application of the theory to stochastic acceleration of a magnetized plasma yields a heating rate that asymptotically approaches that of Puri. Furthermore, a new nonlinear method is presented for obtaining the single-particle distribution function. Applications to ionospheric physics and thermonuclear fusion are discussed. Also, considering a plasma without impressed fields, a procedure is obtained for investigating the nonlinear resonant wave–wave interaction in Vlasov plasmas. Applying this procedure to the water bag model, it is shown that in a two-stream Vlasov plasma, electron-plasma oscillations decay into two groups of waves, each at half the plasma frequency. These wave packets propagate as a result of the nonlinear interaction. Thus, a mechanism for subharmonic resonance is shown. Finally, to illustrate how concepts (such as time between collisions) are useful in kinetic theory, although they lose their significance in the investigation of turbulent systems, the approach to equilibrium of gases with internal degrees of freedom is studied. (Diss. Abstr. Int., B)

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7392 MODEL OF PLASMA EXPANSION. Hantzsche, E. (Zentralinstitut fuer Elektronenphysik, Berlin). Beitr. Plasmaphys.; 10: 397-406(1970). (In German).

The expansion of a small plasma volume as a result of the absorption of a short energy pulse is described by a simple model, with the assumptions: all physical quantities of state are substituted by their spatial mean values, and the main primary equations are the energy and impulse balance of the whole plasma. The initial phase is considered as a stationary one. In this way, explicit expressions may be derived for expansion velocities, kinetic and thermal energies, temperatures, and pressures. Though approximate, these relations allow one to obtain qualitative and—on a limited scale—even quantitative results. For instance, the kinetic expansion energy ranges from $\frac{1}{5}$ to $\frac{1}{2}$ of the total absorbed energy W_0, and the mean temperature T raises $\sim W_0^{\frac{2}{3}}$ during expansion. (auth)

7393 GENERATING FUNCTION FOR EXACT SOLUTION OF KINETIC EQUATIONS OF VLASOV TYPE. Vojta, Guenter (Arbeitsstelle fuer Statistische Physik, Leipzig. Karl-Marx Univ., Leipzig). Beitr. Plasmaphys.; 10: 295-303(1970). (In German).

Kinetic equations of the Vlasov type play a dominant role in the theories of gaseous and semiconductor plasmas (self-consistent field approximation), in the dynamics of quantum systems with collective interactions (Hartree-Fock approximation) and also of spin systems (Weiss molecular field approximation) in the theory of liquids and in astrophysics. Here a new general exact method of solving the linearized Vlasov equation is given in the language of classical plasma theory. This method is based on a series expansion of the distribution function in terms of Hermite polynomials in velocity space. A partial differential equation for the generating function of the time-dependent expansion coefficients is derived and solved, yielding a closed formula for the general term of the series expansion. Thus, the problem of solving the kinetic integro-differential equation is reduced to the more tractable problem of solving a single differential equation, and the mathematical structure of the series expansion becomes very clear. The full equivalence of the solution given with the solution of Van Kampen and Case, in terms of singular normal modes, can be demonstrated. (auth)

7394 ANOMALOUS RESISTIVITY IN A STEADY-STATE, CURRENT-CARRYING DISCHARGE-TUBE PLASMA. Hirose, A.; Alexeff, I.; Jones, W. D.; Kush, S. T.; Lonngren, K. E. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 25: 1563-7 (30 Nov 1970).

The dc conductivity in a turbulent discharge-tube plasma was measured as a function of dc electric field over the range 0.06 to 300 V/cm. Below approximately 60 V/cm the conductivity can be interpreted quantitatively in terms of the ion-acoustic wave instability. Above 60 V/cm the conductivity is approximately constant and about an order of magnitude lower than that calculated by Buneman for the two-stream instability. (auth)

Production

Refer also to abstract 7475.

7395 (IPP-2/85) PRODUCTION AND CONFINEMENT OF ELECTRON CYCLOTRON RESONANCE PLASMAS IN THE WIIa-STELLARATOR. Ellis, R. A. Jr.; Eckhartt, D. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1970. 33p. Dep. NTIS (U. S. Sales Only).

Preliminary measurements of noble gas plasmas generated by low-power cw ECR were made in the stellarator W IIa. Densities were in the range 10^9 to 10^{10} cm^{-3} and electron temperatures ranged from 4 to 11 eV. The general features of the density versus transform curves are quite similar to those observed with barium plasmas produced by contact ionization. The confinement time is estimated to be about 10 Bohm times. The discharges, in general, are turbulent and show fluctuations in the range expected for drift waves. Results are compared with those obtained in other stellarators. (auth)

7396 MOTION OF THE IONIZATION FRONT IN AN ARGON-CESIUM PLASMA IN A MAGNETIC FIELD. Karpukhin, V. T.; Nedospasov, A. V. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 252-6(Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 266-71(Mar-Apr 1970).

New experimental data are given on the influence of a magnetic field on the speed of the ionization front. The speed of the front was found to be different along and across the magnetic field; in an inhomogeneous field, the speed perpendicular to the field depended on the sign of the field. This velocity anisotropy is explained by the release of additional heat by Hall currents circulating near the moving plasma boundary. (auth)

7397 IS BALL LIGHTNING A NUCLEAR PHENOMENON? Altschuler, M. D.; House, L. L.; Hillner, E. (National Center for Atmospheric Research, Boulder, Colo.). Nature (London); 228: 545-6(7 Nov 1970).

Reference is made to cases of high-energy ball lightning, and a few such cases are described, involving an indicated energy density higher than $10^8 J/m^3$. Difficulties associated with attributing the energy storage to ionized gas are discussed; also difficulties with the theory that the energy is maintained by the focusing of microwaves or electric currents into a small volume, for example, through standing waves or converging electric fields. It is considered that none of the theories so far proposed is satisfactory, and the possibility that ball lightning is a nuclear phenomenon is considered. A set of nuclear reactions considered is $^{14}N + p \rightarrow {}^{15}O + \gamma$ and $^{16}O + p \rightarrow {}^{17}F + \gamma$, the protons being supplied by dissociated water molecules in the lightning discharge. If a sufficient quantity of ^{15}O and ^{17}F nuclei could be produced within a small volume, less than 1m diameter, by a lightning stroke, the β decay of these nuclei might produce a ball-lightning effect. The cohesion of the ball would result from a radial electrostatic field in a partially ionized plasma, and it is likely that this field would increase to a large value in the lightning ball. If the field can be limited by ionic drift, the ball will die silently, but if the field cannot be limited, but continues to increase, the ball will assume dazzling brightness and will disappear with an implosive noise. The primary theoretical difficulty with the nuclear hypothesis is the production of sufficient ^{15}O or ^{17}F in a small volume in a time scale of 10^{-3} sec. Possible radiobiological effects are also discussed. It is suggested that the nuclear hypothesis could be tested experimentally by measuring the isotope abundances of air and water immediately after tornadoes, intense thunderstorms, and if possible, ball-lightning decay. If the relative abundances of ^{15}N and ^{17}O are found to be a few tenths per cent higher than normal this result would support the idea of a nuclear origin of ball lightning. (UK)

Stability

Refer also to abstract 7410.

7398 (EUR-CEA-FC-565) NUMERICAL STUDY OF DRIFT INSTABILITIES IN A COLLISIONLESS PLASMA. Brossier, Ph. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1970. 41p. (In French). Dep. NTIS (U. S. Sales Only).

The dispersion relation of drift instabilities in an inhomogeneous plasma is solved for complex values of the frequency. This computation gives the curves with constant growth rate in the wavelength plane. The influence of the following parameters: density, electron to ion temperature ratio, mass ratio, existence of a temperature gradient, is studied. (tr-auth) (France)

7399 (IPP-3/1) PLASMA EQUILIBRIA OF TOKAMAK TYPE. PART I. Zehrfeld, H. P.; Green, B. J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1970. 19p. (In German). Dep. NTIS (U. S. Sales Only).

A general formalism is given for the description of an axisymmetric plasma equilibrium. This is a model for the steady operation of a tokamak device. The hydromagnetic equations taking into account effects such as tensorial resistivity and finite thermal conductivity are used. The reformulation of this set leads to an equivalent set that includes the generalization to toroidal geometry of the Bennett-Pinch relation, and an expression for the resistive plasma loss that shows explicitly the effect of the discharge current. This mathematically concise presentation of the full resistive equilibrium problem is appropriate to practical calculations. As an example, a steady state with no mass sources is considered for the case of small inverse aspect ratio. (auth)

7400 POSSIBILITY OF SUPPRESSING HELICAL MODES OF HYDROMAGNETIC INSTABILITY OF A PLASMA FILAMENT WITH CURRENT BY A SYSTEM OF FEEDBACKS. Arsenin, V. V. This paper was summarized in At. Energ. (USSR); 28: 141-2(Feb 1970) as paper No. 368/5416. (In Russian).

The possibility of suppressing helical modes with the use of a system of feedbacks controlling the perturbation fields in the gap between the plasma and the casing, is considered. This possibility rests on the sensitivity of the large-scale oscillations to the boundary conditions outside the plasma. A theoretical model is described. (M.O.W.)

7401 THEORY OF BEAM INSTABILITIES IN CONFINED PLASMA SYSTEMS. Mamedov, M. A.; Fedorchenko, A. M. Radiotekh. Elektron.; 15: 1976-9(Sep 1970). (In Russian).

Spatial increases in building up quasi-static oscillations in confined plasma with a homogeneous electron beam passing through at velocity $\vec{v}_0$ were calculated on the basis of kinetic theory. The cylindrical column of plasma confined by a strong external magnetic field $\vec{H}_0 || \vec{v}_0$ and surrounded by a dielectric sheath was studied, considering that the stationary part of the distribution function was assigned and consisted of two parts (for the basic plasma electrons in the form of Maxwell distribution and for the electron beam in δ function form). (R.V.J.)

7402 CRITICAL ROTATIONAL VELOCITIES IN TOROIDALLY CONFINED PLASMA. Taniuti, T. (Nagoya Univ., Japan). Phys. Rev. Lett.; 25: 1478-9(23 Nov 1970).

Critical rotational velocities about the magnetic axis in a toroidally confined plasma are derived from a kinematical condition for the formation of spatial discontinuities (steady shock waves) in ideal magnetohydrodynamics. (auth)

7403 DYNAMIC STABILIZATION OF DRIFT WAVES BY AC ELECTRIC FIELDS. Sciarra, R.; Dobrowolny, M.; Magistrelli, F. (EURATOM–CNEN, Frascati, Italy). Phys. Rev. Lett.; 25: 1553-5(30 Nov 1970).

Experimental results are reported on the dynamic stabilization of drift waves in a Q machine plasma by means of ac electric fields parallel to the magnetic field. Appreciable stabilization was obtained both at ac frequencies around the wave frequency and at very high ac frequencies. (auth)

7404 EVOLUTION AND LARGE-ELECTRIC-FIELD SUPPRESSION OF THE TRANSVERSE KELVIN–HELMHOLTZ INSTABILITY. Jassby, D. L. (Princeton Univ., N. J.). Phys. Rev. Lett.; 25: 1567-70(30 Nov 1970).

The interior of a plasma column is subjected to shear of arbitrary magnitude in the $\vec{E} \times \vec{B}$ rotation. The resultant Kelvin–Helmholtz instability undergoes an evolution in mode structure as the radial electric field is increased, and is suppressed when the Doppler-shifted wave frequency equals 0.5 to 0.65 times the ion–cyclotron frequency. Cyclotron waves appear concomitant with this suppression; these have properties in agreement with linear fluid theory. (auth)

Thermonuclear Processes

Refer also to abstracts 6587, 7362, 7363, 7365, and 7924.

7405 (CEA-CONF–1661) TOKAMAK FACILITY OF FONTENAY-AUX-ROSES: T.F.R. Beraud, J. L.; Rebut, P. H.; Huguet, M.; Sledziewski, Z.; Torossian, A. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 6p. (CONF-700928–3). Dep. NTIS (U. S. Sales Only).

From 6th Symposium on Fusion Technology, Aachen, Germany.

A T3-sized Tokamak device energized by a recently developed 100 MW alternator supplying 150 MJ at a repetition rate of one pulse every four minutes is described. The maximum diameter of the torus is 2 meters, the internal diameter of the coil 0.6 meters and the on-axis magnetic field is 60 kG. (France)

7406 (CEA-CONF–1662) FAST NEUTRAL HYDROGEN ATOM INJECTOR. Bariaud, A.; Becherer, R.; Dei-Cas, R.; Druaux, J.; Valckx, F. P. G. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 7p. (CONF-700928–2). Dep. NTIS.

From 6th Symposium on Fusion Technology, Aachen, Germany.

This fast-neutral injector facility was built to test the feasibility of obtaining an intense neutral excited hydrogen atom beam in a good vacuum for a multi-injection project. H_3^+ ions were chosen for the following reasons: the extraction is easier; the production efficiency of excited atoms is higher with a thick vapor target; the energy can be varied without significantly affecting this efficiency. The experimental device consists of an ion source of the type developed at Sukhumi and Oak Ridge, a neutralizer that uses a supersonic Mg vapor jet for the neutralization of the ion beam and partial breakup of the neutral gas jet coming from the source, deflection magnet to eliminate the charged beam fraction, a differential pumping column using titanium getter pumps, and an analyzing device to measure the state of excitation of the atoms. The aim of this experiment was to obtain a beam of excited atoms with the following characteristics: energy 20 keV, intensity 100 mA eq., with a pressure in the central region of 10^{-8} torr. (auth) (France)

7407 (CEA-CONF–1663) SUPERCONDUCTING QUADRUPOLAR COIL FOR A NEUTRAL ATOM MULTI-INJECTION EXPERIMENT. Asesio, P.; Berruyer, A.; Bronca, G.; Krikorian, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Dei-Cas, R.; Hennion, F.; Tachon, J.; Valckx, F. P. G. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 7p. (CONF-700928–1). Dep. NTIS (U. S. Sales Only).

From 6th Symposium on Fusion Technology, Aachen, Germany.

In order to suppress the anisotropy and loss-cone drift instabilities that can develop in minimum-B devices, a plasma produced in a magnetic well by ten neutral beams injected at different angles was proposed. Due to the long duration (≈10 s) and high value of the magnetic field necessary for such a plasma, a superconducting quadrupolar coil (dimensions: 115 × 80 × 80 cm; B at the center 15 kG, 10 kG at the mirror) was suggested. The coil shape was chosen for easy access to the beams and associated equipment. To reduce the wall desorption under fast-particle impact, the liner must be baked at 400°C and, in operation, should be near room temperature. The main technological problems connected with this project are discussed: the maximum magnetic field and mechanical stress on the conductors, cryogenic aspects, and vacuum during the beam injection. (auth) (France)

7408 (CEA-CONF–1664) TORSATRON WITHOUT TOROIDAL FIELD COILS AS A POSSIBLE SOLUTION TO THE DIVERTOR PROBLEM IN A FUSION REACTOR. Gourdon, C.; Marty, D.; Touche, J. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 6p. (CONF-700928–4). Dep. NTIS (U. S. Sales Only).

From 6th Symposium on Fusion Technology, Aachen, Germany.

During the last few years, a systematic study of the stellarator-type magnetic configuration has been made by accurate numerical integration of the magnetic lines. This study enabled the introduction of a new type of stellarator configuration, Torsatron, with only one set of helical conductors passing currents in the same direction instead of opposite directions such as in the classical type of stellarator. A peculiar regime in which the whole toroidal field is created only by the helical current was found to have very interesting properties. With large aspect ratio ($R/a \sim 10$) in the $I = 3$ case, high values for the rotational transform ($L/2\pi = 4$) and high shear ($\theta = r_p/L_s \sim 1$) can be reached. The simplicity of the windings and the particular shape of the separatrix can be used in the design of an efficient divertor. The absence of toroidal field coils permits the extremely large pumping apertures required to maintain a low equilibrium pressure in the divertor chamber under reactor conditions, the neutral gas density around the plasma being about 2×10^{11} cm^{-3}. (auth) (France)

7409 (CEA-CONF–1665) CIRCULARIZED QUADRUPOLAR MAGNETIC WELL: DECA II B. Lecoustey, P.; Tachon, J. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 8p. (CONF-700928–5). Dep. NTIS (U. S. Sales Only).

From 6th Symposium on Fusion Technology, Aachen, Germany.

A new way to reduce the plasma wall interaction in a magnetic well is proposed. It involves the focusing of the magnetic field lines on the outside of the mirror region by two additional quadrupolar windings. The application of this concept to the rebuilding of DECA II B experiment is described. (auth) (France)

7410 (GA–10278) CONTROLLED THERMONUCLEAR RESEARCH PROGRAM. Summary Progress Report, August 1, 1969–July 31, 1970. Ohkawa, T. (Gulf General Atomic, Inc., San Diego, Calif.). 15 Sep 1970. Contract AT(04-3)-167. 84p. Dep. NTIS.

The program consists of experiments with two devices, namely, the dc octopole and the Doublet-II, and the supporting theoretical efforts. The dc octopole was completed in the previous contract year and has now demonstrated good plasma confinement. A containment time of 500 Bohm times has been observed in the collisionless regime. In the collisional regime the plasma behavior may be explained by classical theory. Except for a small discrepancy of a numerical factor, the plasma loss has the characteristics of resistive diffusion. The dc octopole has been and will be productive as a test bed for studying the plasma in toroidal geometry. The effects of field errors, background gases, properties of plasma convection cells, heating of plasma, propagation properties of waves, and trapped particle instabilities are examples. It is planned to add a toroidal field to the dc octopole device. The main subject will be the study of the relative importance of the symmetry of the configuration and the transform angle or the shear. The construction of the Doublet-II device is in progress. The submarine batteries, which will be used as the power source for the toroidal magnetic field for both the Doublet-II and dc octopole, have been installed. The vacuum chamber has been delivered. The design of the coils for the toroidal magnetic field and the coils for the toroidal electric field has been com-

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pleted. The order for the condenser bank for powering the electric field coils has been placed. It is expected that the device should be completed in this contract year. The theoretical efforts are directed toward the understanding of the plasma behavior in the dc octopole and the analysis of the equilibrium and the stability of Doublet configurations. A novel method was found for maintaining a current in Tokamak and Doublet-like plasmas. Dual beams of ions may drive a current in the plasma and also heat the plasma in the thermonuclear regime. (M.O.W.)

7411 (IPP-4/68) 500 kV THETA PINCH PROJECT. Herppich, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov 1969. 38p. (In German). Dep. NTIS (U. S. Sales Only).

The designed theta pinch with a four times fed coil (43 cm diameter, 100 cm length) will be driven by Blumlein-type transmission lines (0.58 Ω). The lines generate a 125 kV pulse (total voltage 500 kV at the closed circuit) of 500 ns length with a rise time constant of 85 ns. The corresponding field is 5.5 kG. The Blumlein lines are resonance charged by a capacitor bank of the Marx type. The start switches are pressurized multichannel spark gaps. The bias field bank consists of two parts. One part is connected directly with the coil like the main bank. The other part feeds into two single-turn coils left and right of the main coil in order to produce a homogeneous field even 20 cm outside the main coil. Two smaller Blumlein lines (100/200 ns) were built for studying technical and physical properties. Most of the electrical and discharge data are checked and computed with an ECAP program on the IBM 360/91. (auth)

7412 (IPP-4/70) PROBLEMS IN THE PRODUCTION OF LARGE-VOLUME MAGNETIC FIELDS FOR FUSION REACTORS. Kafka, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar 1970. 29p. (In German). Dep. NTIS (U. S. Sales Only).

The production of high magnetic fields in large volumes is studied here for a toroidal configuration with a field volume of 1000 m^3, maximum magnetic field of 100 kOe, and an energy content of 10^{10} J. It is investigated whether the prime and operating costs can be appreciably reduced by using a superconducting winding, and whether the resulting technical problems can be solved. It is suggested that a cable made of Nb–Ti strands insulated with loose braiding and surrounded by an aluminum alloy sheath extruded around the cable be used as superconductor for about 10 kA. The strands themselves are twisted bundled conductors with high-purity copper matrix. Inside the sheath they are in direct contact with the coolant, which is supercritical helium either in liquid form or cooled to about 4.5°K. A small part of the magnetic forces is absorbed by the conductor cable, a large part by the sheath, and the rest by an armature wound on the winding under tension. In this type of conductor the extraction of energy is encouraged by the fact that a longitudinal flow of heated coolant quickly propagates the quench over a coil section. There is, therefore, hope that all problems can be solved even for superconducting windings, and that the prime and operating costs can then be reduced to 10 to 20% of those for water-cooled windings. The appendix lists formulas for calculating hysteresis and eddy-current losses of superconductors in varying fields and gives a criterion on which to base the two types of losses in bundled conductors of a given pitch. (auth)

7413 (IPP-4/78) COMPARISON OF DIFFERENT CONCEPTS OF FUSION REACTOR BLANKETS AND THERMODYNAMIC CIRCUITS. Daenner, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1970. 50p. (In German). Dep. NTIS (U. S. Sales Only).

The main tasks of the single blanket zones are pointed out. Based upon some typical blanket concepts, the influence of the vacuum wall, structural material volume fraction, ^{6}Li concentration, addition of beryllium and/or sodium on the tritium breeding ratio and energy release is outlined. Some remarks about the use of flibe instead of liquid lithium are added with respect to both a separate fusion reactor and a hybrid system. After a short consideration of the radial energy distribution in the blanket, two possible concepts of thermodynamic circuits are contemplated: the liquid metal–steam concept and the direct helium circuit. The advantages and disadvantages of both concepts are confronted, and some basic problems of their development are mentioned. (auth)

7414 (ORNL-TM-2822(Rev.)) PRELIMINARY APPRAISAL OF THE HAZARDS PROBLEMS OF A D-T FUSION REACTOR POWER PLANT. Fraas, A. P.; Postma, H. (Oak Ridge National Lab., Tenn.). Dec 1970. Contract W-7405-eng-26. 37p. Dep. NTIS.

A preliminary assessment of the hazards problems of a D–T fusion reactor was made to provide some notion of the seriousness of these problems in possible future applications of thermonuclear power plants. The inherent characteristics of magnetically confined plasmas appear to be such that any tendency toward general power overshoots or local hot spots will be more than compensated by other factors, so that there should be no difficulties with either general or local temperature or power excursions that might cause a meltdown or an explosion. In turning to radiological hazards, the principal source of concern is tritium. Fortunately, fusion reactor systems will ordinarily be designed so that the bulk of the tritium produced will be consumed as fuel. Thus, though the tritium production rate will run roughly 10,000 times that in a fission reactor, by proper plant design the tritium inventory can be kept to about the same level as in a conventional fission reactor such as a PWR. Inasmuch as the tritium leakage rate from the plant depends on the inventory, it appears that the tritium leakage problem is thus roughly comparable for fission and fusion plants. However, the fusion reactor has the additional advantage that the tritium can be kept from mixing with water so that, in the fusion reactor concept involving a potassium vapor topping cycle, one is not confronted with the choice of either sequestering large volumes of dilute aqueous solutions or employing an isotope separation process. The afterheat in the fusion reactor considered here is about 0.2% of the full power output, i.e., about one-tenth as much as in a fission reactor. The afterheat production will be distributed through the large volume and mass of the blanket region rather than concentrated as in the fuel elements of a fission reactor. Thus, though it may be necessary to provide for afterheat cooling in the engineering design, it is a less-serious problem than in fission reactors. (auth)

7415 (ORNL-TM-3097) CRYOGENIC SYSTEM FOR THE SUPERCONDUCTING MAGNETS OF A FULL-SCALE THERMONUCLEAR POWER PLANT. Fraas, A. P. (Oak Ridge National Lab., Tenn.). Dec 1970. Contract W-7405-eng-26. 11p. Dep. NTIS.

A preliminary estimate was made of the heat load on a cryogenic system for cooling the superconductivity coils of a 5000-MW(t) thermonuclear power plant. The size, cost, and power requirements for this cryogenic system were then estimated, using data for the large liquid-helium refrigeration system employed for the 65-ft diameter by 125-ft-tall space-simulation chamber at the NASA Manned Space Flight Center at Houston. (auth)

7416 (ORNL-TM-3222) REVIEW OF THE ORNL FUSION FEASIBILITY STUDIES. Steiner, Don (Oak Ridge National Lab., Tenn.). Dec 1970. Contract W-7405-eng-26. 31p. Dep. NTIS.

The conceptual fusion reactor, which has been the basis for the ORNL investigations, is described; then, the scope of the ORNL studies is discussed briefly; next, the ORNL investigations in the areas of radiation damage, environmental considerations, and alternate fuel cycles are discussed in detail; finally, the direction of the ORNL studies for the coming year is indicated.(auth)

7417 (ORNL-TM-3233) NUCLEAR FUSION RESONANCE REACTIONS OF POSSIBLE CTR INTEREST. McNally, J. Rand Jr. (Oak Ridge National Lab., Tenn.). Dec 1970. Contract W-7405-eng-26. 7p. Dep. NTIS.

Some speculations are presented on possible nuclear fusion resonance reactions which may be of importance to the development of "clean" controlled thermonuclear reactors of either toroidal or mirror type. (auth)

7418 (UCRL-72317) ULTRA-HIGH-VACUUM TECHNIQUES FOR CONTROLLED FUSION RESEARCH. Batzer, T. H. (California Univ., Livermore. Lawrence Radiation Lab.). 23 Mar 1970. 6p. (CONF-700912-7). Dep. NTIS.

From 5th Annual Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev.

Plasmas of interest in controlled fusion research have temperatures and particle densities greater than 10^{7}°K and 10^{10} particles/cm^3, requiring containment in vacuum by magnetic fields. Without regard to the containment stability of the magnetic field geometry, the principal plasma loss mechanism is charge exchange with the residual gas or vacuum in which it is immersed. The density and composition of the contaminating residual gas are associated with the base-pressure limitations of available vacuum systems, desorption from the vacuum wall, and cold gas streaming in from plasma sources, such as plasma guns or high-energy (>1 keV) neutral beam tubes. For useful plasma lifetimes, residual gas density should be held below 10^{8} particles/cm^3 or about 10^{-10} torr. The vacuum techniques developed to approach this goal, such as all-metal, bakeable vacuum systems, high-speed surface pumps, and devices to reduce beam-tube gas streaming, are discussed. (auth)

7419 (UCRL-72329) HEAT PIPES FOR RECOVERY OF TRITIUM IN THERMONUCLEAR REACTOR BLANKETS. Werner, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Mar 1970. 7p. (CONF-700912-9). Dep. NTIS.

From 5th Annual Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev.

Controlled thermonuclear reactors, using deuterium–tritium as a fuel for the fusion reaction, require a means of regenerating tritium so that cycle continuity is maintained. This paper suggests a unique way for satisfying the tritium needs. It is proposed that heat pipes using sodium as a working fluid be used in tritium transporters in the blanket structure of a fusion reactor. The tritium produced by the reactions ($n + {}^6Li \rightarrow T + {}^4He + 4.8$ MeV) and ($n + {}^7Li \rightarrow n^1 + T - 2.47$ MeV) in the lithium moderator of the blanket would be diffused through the heat-pipe tube wall and transported within the heat-pipe body to an accessible processing point outside the blanket. By diffusion through the tube wall to a vacuum environment for the second step, the tritium would be brought outside the heat-pipe body and then processed for recycling. Heat pipes are explained as heat-transfer devices and as gas handlers in a fusion reactor environment. (auth)

7420 QUICK-OPENING ELECTROMAGNETIC VALVE. Geiger, Max; Schenk, Gunter (to EURATOM). British Patent 1,214,685. 2 Dec 1970. Priority date 6 Mar 1967, Italy.

The invention relates to a quick-opening value for discharging pressurized gas in pulses. The value is most useful when the amount of gas supplied during the pulse must be as large as possible, while the pulse must be brief and the volume of gas supplied must be free of contamination. (M.C.W.)

7421 STUDY OF THE FEASIBILITY OF STEADY-STATE SELF-HEATED CONTROLLED THERMONUCLEAR POWER REACTORS. Husseiny, Abdelfattah Ahmed. Madison, Wis.; Univ. of Wisconsin (1970). 334p. University Microfilms Order No. 70-12,736.

Thesis.

The importance of various energy- and particle-loss processes from the plasma reaction volume relative to bremsstrahlung radiation loss is investigated for a wide range of kinetic energies. A unified method for reaction rate calculation is developed that can be used for charged particles and neutrons, whether in the plasma core or in the neutron blanket. The method is applied to the calculation of elastic scattering and fusion reaction rates for particles produced from primary fusion reactions. Emphasis is made on the effect of the thermal motion of the plasma particles on reducing the scattering rate and the secondary fusion rate. The use of the Breit–Wigner–Eisenbud formula for the representation of the resonance observed in the D–T and D–^{3}He reaction cross section makes it possible to calculate the Doppler-broadened cross sections. A scattering kernel for the encounters between reaction-produced particles and plasma particles is developed. The kernel is then used to evaluate the scattering moments. These calculations enabled one to obtain the rate of energy transfer from charged-reaction particles to the plasma particles. Also, the dispersion, the mean deflection, and the energy relaxation rates are calculated. Considering distant encounters only, the distribution, average density, and average energy are evaluated for the energy range at which the plasma particles are considered as fixed scattering centers. The results are also extended to lower energies. Characteristic times for a fusion plasma are investigated. The lifetime of plasma ions, the slowing-down time and the thermalization time for reaction particles are obtained. Effects of fusion events on the lifetime of fusile ion are studied. The secondary fusion reactions between fusile reaction particles and plasma particles are given some attention. The reactions involving tritium and helium-3 in pure deuterium reactors are also considered. The mean energy and the average density of the reaction particles and the rate of energy transfer are used to formulate the dynamic equations of the reactor. A design criteria is given for a feasible steady-state self-heated reactor from a comparison of the different conditions on the reactor parameters. (TSS) (Diss. Abstr. Int., B)

7422 ION-SLIP LIMITATIONS ON CURRENTS IN HALL-EFFECT PLASMA ACCELERATORS. Henry, Roger Pearson. Toronto; Univ. of Toronto (1968).

Thesis.

A refined Ohm's law is developed to relate the current components in a coaxial Hall-current plasma accelerator to the collisional properties of the plasma. The inclusion of electron–electron interaction in this "thirteen-moment" solution produces Hall and ion-slip coefficients differing somewhat from those of Cowling's Ohm's law. As a result of ion-slip phenomena, the ratio of Hall to electrode current has a maximum at a specific magnetic field. Both this ratio, and the field needed to produce it, are shown to be essentially the same when calculated by either the Cowling or the "thirteen-moment" expression. Collison data for argon and helium are used to calculate maximum Hall current ratios and corresponding magnetic fields over the pressure ranges 1 to 10^{-4} atmospheres. Although argon produces higher Hall-current ratios than does helium, both tend to exhibit lower values at intermediate temperatures (where arc operation is more usual) than at either very low or very high temperatures. Preionization or "seeding" is shown to reduce this ratio further, particularly at low ionization levels. A test device was constructed in which measurements of Hall-to-electrode current ratios were made. Although never exceeding 10, these ratios and their dependence upon plasma conditions tend to substantiate the theoretical predictions. (Diss. Abstr. Int., B)

Wave Phenomena

Refer also to abstracts 7380 and 7391.

7423 (IPPJ–98) NONLINEAR BEHAVIORS OF ION-WAVE. Kako, Masashi; Watanabe, Tsuguhiro (Nagoya Univ. (Japan). Inst. of Plasma Physics). Aug 1970. 20p. Dep. NTIS (U. S. Sales Only).

The following equation is shown to govern the finite-amplitude ion-wave propagating through a macroscopic plasma with an ion beam in the neighborhood of a marginally stable state:

$$\frac{\partial^2\psi}{\partial\tau^2} + \alpha\frac{\partial^2\psi}{\partial\xi^2} + \frac{\partial^4\psi}{\partial\xi^4} + \frac{\partial^2\psi^2}{\partial\xi^2} = 0,$$

where α denotes the deviation of the plasma system from the marginal state. It is found that wave trains or solitary waves exist. The temporal evolution of initial disturbances is investigated numerically. (auth) (Japan)

7424 (IPPJ–99) UNSTABLE BGK SOLUTION DUE TO EXCITATION OF AN ION ACOUSTIC WAVE. Hatori, T.; Sugihara, R.; Watanabe, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1970. 10p. Dep. NTIS (U. S. Sales Only).

Some comments on the stability of the BGK solutions are given using idealized models, and a possibility is shown of excitation of an ion–acoustic wave by trapped electrons in a large-amplitude potential trough. (auth) (Japan)

7425 (UCRL–50900) CONDITIONS FOR LANDAU DAMPING AND WAVE REFLECTIONS IN OPEN-ENDED MAGNETIC WELL PLASMAS. Hamilton, Gordon W.; Moir, Ralph W. (California Univ., Livermore. Lawrence Radiation Lab.). 3 Jun 1970. 15p. Dep. NTIS.

Conditions are examined for Landau damping and wave reflections of convective electron plasma waves in open-ended magnetic-well plasmas. Velocity-matching ($v_e = v_{wave}$) is a necessary but not a sufficient condition for stability due to Landau damping. One finds that the necessary conditions required for damping by velocity-matching are always satisfied towards the end of the plasma where the density is dropping off, provided the wave can propagate to that point before reflection occurs. However, Baseball I data shows that velocity matching is not a sufficient condition for stability. Necessary conditions can be satisfied for a sufficiently strong magnetic field or for a sufficiently smooth (collisional) density profile; however, further analysis is required to determine the sufficient conditions for stability. (auth)

7426 ELECTRON AND ION SIGNAL PROPAGATION IN A QUIESCENT PLASMA. Proni, John Roberto. Raleigh, N. C.; North Carolina State Univ. (1970). 131p. University Microfilms Order No. 70-12,833.

Thesis.

Results of studies carried out on electron and ion pulse propagation in a plasma are presented. The results of an investigation carried out into the nature of the plasma formed interior to a helical electron beam are also presented. Finally, the results of investigations into various transmitting and receiving antennas are discussed. Two apparently distinct types of ion pulses were studied. These are the ion–acoustic pulse and the ion–ballistic pulse. The ion–ballistic pulse is found to have a speed of propagation which is dependent upon the amplitude of the applied voltage pulse. The ion–acoustic pulse speed of propagation is independent of the amplitude (within the voltage range 6 to 50 volts) of the applied voltage pulse. The ion–ballistic pulse is generated more easily when the transmitting antenna is negative (≈–50 volts) with respect to the plasma. Multiple reflections of both types of ion pulses were observed. Ion pulses launched by sinusoidal signals have likewise been observed. Studies were carried out on direct electromagnetic coupling of the transmitting and receiving antennas. These studies indicated that the transmitter–receiver system acts like a differentiating circuit. Finally, electron responses to fast (100 nsec) pulses were observed. An oscillatory electron response to an applied voltage pulse was studied. (Diss. Abstr. Int., B)

7427 RAPID-DISPLAY METHOD FOR DISPERSION CHARACTERISTICS. Forrest, John R. (Stanford Univ., Calif.). J. Phys., E (London); 3: 904–6(Nov 1970).

XUM

A simple technique for the rapid display of dispersion characteristics applicable to any dispersive medium is described. Results are presented for the propagation of ionization waves in the frequency range 5 to 50 kHz on a helium gas discharge. Comparison with previous point by point determinations shows that not only is the measurement time drastically reduced, but also a reduction in random error is obtained. (auth) (UK)

7428 AMPLIFICATION OF ION PLASMA WAVES OWING TO BEAM–PLASMA INTERACTIONS. Leven, Ronald (Univ., Greifswald, Ger.). Beitr. Plasmaphys.; 10: 348-55(1970). (In German).

The amplification of low frequency electrostatic waves as the result of beam–plasma interaction is considered. In order to find the dependence of the growth rate from frequency and the plasma parameters the dispersion equation is solved numerically for some given values of ion and electron temperatures and the drift velocity of the electrons. The results show positive growth rates (amplification) in the whole frequency range $0 < \omega \lesssim \omega_i$, where ω_i is the corresponding ion plasma frequency. The growth rates are large for low temperatures and decrease with rising temperatures and decreasing drift velocity. The phase velocity increases with rising temperatures. (auth)

7429 NONPOTENTIAL ION HARMONIC WAVES. Stefant, Robert J. (Univ. of California, Berkeley). J. Geophys. Res.; 75: 7182-92(1 Dec 1970).

The propagation characteristics of nonpotential ion-cyclotron waves traveling at very large angles to the unperturbed magnetic field are discussed. The wave dispersion relationship is derived in situations using a power series or an asymptotic expansion for the plasma dispersion function, namely, when the phase velocity is less than the electron thermal speed, or when the phase velocity is greater than the electron thermal speed. When the phase velocity is less than the electron thermal speed, it is shown that the analysis includes not only the electrostatic wave investigated by W. E. Drummond and M. N. Rosenbluth, but also a slightly damped nonpotential ion-cyclotron mode for any ratio of the plasma pressure to magnetic pressure β. When the phase velocity is greater than the electron thermal speed only the nonpotential ion-cyclotron modes exist. These waves have $(E \cdot k)/(E \wedge k) \gtrsim 1$ near the cyclotron harmonics, i.e., at large values of k_z (wave number parallel to the magnetic field). At smaller values of k_z the ion-cyclotron modes tend to be mostly longitudinal. Numerical solutions of the wave dispersion relationship are obtained, and application is made to some relevant space observations. It is shown that the fine structure of the proton whistlers recently observed by D. A. Gurnett and others is well explained by the propagation characteristics of ion (O^+) harmonic waves through the ionosphere. Attention is also paid to the recent satellite observations of proton harmonic waves. Finally, the properties of these slow waves near the lower hybrid frequency are discussed. (auth)

7430 METHOD OF CONSTRUCTING GENERAL SOLUTIONS OF CERTAIN NONLINEAR DIFFERENTIAL EQUATIONS DESCRIBING PLASMA OSCILLATIONS. Barrett, E. B. (Naval Postgraduate School, Monterey, Calif.). J. Math. Phys. (N. Y.); 11: 3165-7(Nov 1970).

A general solution is derived for a system of nonlinear partial differential equations describing longitudinal plasma oscillations. The method of construction of the solution involves the imposition of arbitrary functional relationships among the integrals of an associated system of ordinary differential equations. (auth)

Shielding

Refer also to abstracts 6473–6475, 7131, 7509, 7587, 7931, 8062, 8063, and 8120.

7431 (CSIRO-Trans-10069) SPATIAL DISTRIBUTION OF EPITHERMAL NEUTRONS IN A TWO-LAYERED MEDIUM WITH A CYLINDRICAL BOUNDARY. Rudyk, B. M. Translated by B. Bergmanis (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Tr. Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 89-106(1968). 34p. Dep. NTIS (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 24: 10597 (1970). (Australia)

7432 (ORNL-4626) NEUTRON AND SECONDARY GAMMA-RAY INDUCED HEAT IN THE GROUND DUE TO POINT 12.2 TO 15-MeV AND FISSION SOURCES AT AN ALTITUDE OF 50 FEET. Straker, E. A.; Emmett, M. B.; Gritzner, M. L. (Oak Ridge National Lab., Tenn.). Nov 1970. Contract W-7405-eng-26. 41p. Dep. NTIS.

The energy deposited in ground due to neutrons and the secondary gamma rays was determined as a function of range, ground depth, and time from an instantaneous point neutron source with either a fission spectrum or a 12.2- to 15-MeV energy band. In all cases, the source was at a height of 50 feet above the air/ground interface. Discrete ordinates and Monte Carlo calculations illustrated that there is a significant effect on the energy deposited due to source energy distribution, but little effect due to small differences in ground composition. The importance of gamma rays produced by low-energy neutrons was found to be small for the 12.2- to 15-MeV source, but large for the fission source. (auth)

7433 ABSORPTION METHOD FOR DETERMINING THE ENERGY DISTRIBUTION OF ELECTRONS INCIDENT ON AND TRANSMITTED THROUGH A SHIELD. Baranov, V. F.; Zaitsev, R. Ya.; Nalivaev, V. I. This paper was summarized in At. Energ. (USSR); 28: 237-8(Mar 1970) as paper No. 378/5474. (In Russian).

A method is described for calculating the energy distribution of electrons incident on and transmitted through a shield of finite thickness if the functions I(x), describing the attenuation of the radiation current with a continuous spectrum n(E), and $F(x,R_e)$, describing the attenuation of the monoenergetic electron current in shields of various thickness are known. The relation between the number of transmitted electrons I(x) of the continuous spectrum and the thickness of the shield x is described by a Volterra integral equation of the first kind and may be measured or computed with the necessary accuracy. The function $F(x,R_e)$ is approximated by simple expressions since the number of particles transmitted through the shield is not explicitly dependent on the energy and the angle of incidence of the electrons if the shield thickness is expressed in units of the extrapolated electron range R_e. Approximate expressions are presented for $F(x,R_e)$ and corresponding solutions of the integral equation for the spectrum of the electrons incident on the shield N(x) and the spectrum of the electrons transmitted through the shield $N_d(x)$. In this case, the solution of the integral equation for $N(x_k)$ or $N_d(x_k)$ is expressed in terms of tabulated integrals or Whittaker's confluent hypergeometric functions. To test the proposed method of calculating the energy distribution of electrons incident on and transmitted through a shield the energy distributions of scattered β particles outside aluminum and tissue-equivalent (celluloid) shields were measured for normal incidence of β particles from ^{147}Pm, ^{185}W, ^{204}Te, ^{143}Pr, ^{32}P, and $^{90}Sr + ^{90}Y$ sources. The experimental and calculated data agree within ±(10 to 20)%. (TSS)

7434 MEASUREMENTS AND CALCULATIONS OF γ-SPECTRA IN A BENT CONCRETE DUCT. Domann, H.; Frisius, F.; Lahann, H.-J.; Wille, P. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie; 15: 227-30(1970). (In German).

The pulse-height distributions of a ^{60}Co source were measured with a NaI detector as a function of the position of the detector in a rectangular concrete duct. The gamma spectra were calculated with MOCADUCT, a Monte Carlo code. With the response function of the NaI detector, the calculated gamma spectra were transformed into fictive pulse-height distributions of the NaI detector. The agreement between both spectra is considered to be good. (auth)

7435 HIGH-ENERGY GAMMA-R... ATTENUATION THROUGH SLABS OF CONCRETE, IRON, AND LEAD. Risher, Daniel Harrison Jr. Charlottesville, Va.; Univ. of Virginia (1969). 209p. University Microfilms Order No. 70-8089. Thesis.

The attenuation of high-energy gamma rays through slabs of concrete, iron and lead was measured. The high-energy gamma rays were produced by the neutron-capture gamma-ray reaction in titanium and nickel targets, which were placed near the core of the University of Virginia reactor. The well-collimated and filtered beam was nearly monoenergetic, with an average energy of 6.47 and 8.23 MeV, respectively, for the titanium and nickel targets. A dosimetry system was developed to measure the exposure behind the slab shields. The dosimeter employed an equilibrated anthracene scintillator crystal, and a digital pulse integrator to convert the phototube output pulses to a digital representation of the absorbed energy in the crystal. The dosimeter response with a ¾-inch equilibrator was very nearly isotropic, and proportional to kerma for air within ±6% from 400 keV to 9 MeV. The response was essentially dose-rate independent from .02 to greater than 40 mR/hr. Total and narrow beam geometry exposure ratios and buildup factors were obtained for a normally incident monodirectional gamma-ray source. An automatic scanning device was built to facilitate in the collection of the total exposure in a plane behind the shield. The spatial distribution of the exposure was also measured. The results in concrete and in iron at 6.47 MeV were found to compare well with moments and

Monte Carlo calculations. At 8.23 MeV in iron and 6.47 MeV in lead, the experimental buildup factors were up to 15% higher than calculated. This difference increased to 30% at 8.23 MeV in lead. The difference was attributed to effects that become important for high-Z materials and high gamma-ray energies. Two such effects were considered: bremsstrahlung, and electron production in the shield. Electron production was shown to have a negligible effect on the total exposure. However, the results of a calculation by another experimenter showed that bremsstrahlung could account for much if not all of the 30% difference. A comparison was also presented between the results of moments and Monte Carlo calculation. The effect of the neglecting of annihilation radiation in the moments calculation was evaluated and found to be about 4% in iron for an 8 MeV gamma-ray source. Differences between the moments and Monte Carlo calculations were attributed to a combination of the effect of annihilation radiation, and the use of different cross sections in the two calculations. (Diss. Abstr. Int., B)

7436 ANGULAR DISTRIBUTION OF MONOENERGETIC ELECTRONS AND BETA PARTICLES SCATTERED IN A SHIELD. Baranov, V. F.; Bondarenko, N. P.; Burmagin, L. I.; Zaitsev, R. Ya.; Kudinov, V. V.; Nalivaev, V. I. This paper was summarized in At. Energ. (USSR); 28: 237(Mar 1970) as paper No. 377/5473. (In Russian).

The angular distribution of electrons scattered in shields of thickness $d \geq t$, where t is the thickness of the Moeller layer, was investigated. The primary electrons were monoenergetic with energies varied from 0.4 to 1.8 MeV in 0.2 MeV steps, and were incident normally ($\theta_0 = 0^0$) on shields of atomic numbers 6.3 (celluloid), 13 (aluminum), 42 (molybdenum), and 74 (tungsten). The shield thickness varied from $d/R_0 = 0.005$ to 0.7, where R_0 is the true range of an electron of energy E_0 in material of atomic number Z. The average statistical error in the measured values of the angular distribution of scattered electrons was ±2% for a shield thickness $d = t$, and ±5% for $d > t$. The angular distributions of scattered electrons outside an aluminum shield of thickness comparable to the Moeller layer were measured and also computed by Moeller's theory for the multiple scattering of electrons of 1.2 and 1.4 MeV incident normally. The calculated and measured values are in good agreement. The experimentally determined angular distributions of electrons with initial energies in the range indicated incident normally on shields of thickness $d > t$ were compared with results obtained by the Monte Carlo method. The angular distributions of electrons scattered in shields were approximated. The angular distributions of beta particles $I_\beta(\theta)$ scattered in shields with Z = 6.3 and 13 were also investigated for normal incidence ($\theta_0 = 0^0$) of β particles from the radioactive isotopes: ^{147}Pm, ^{185}W, ^{204}Te, ^{143}Pr, ^{32}P, and $^{90}Sr-^{90}Y$. The angular distributions of β particles calculated agree with the measured values within the limits of experimental error. The method described permits the establishment of a relation between the current density and the flux density of electrons and β particles that have penetrated a shield of material of atomic number Z and thickness d by knowing only the shape of the β spectrum or the energy of monoenergetic electrons incident on the shield. (TSS)

7437 ALBEDO OF BREMSSTRAHLUNG γ RADIATION. Zol'nikov, P. P.; Dvinyaninov, B. L.; Sukhanova, K. A. This paper was summarized in At. Energ. (USSR); 28: 235-6(Mar 1970) as paper No. 376/5462. (In Russian).

Using the method of numerical integration and a computer, the integral and differential characteristics of the numerical and energy albedos of bremsstrahlung radiation were calculated with the maximum energies $E_{\gamma,max} = 1, 3, 5, 10, 15, 25, 50, 100$ MeV in reflection from aluminum, iron, and lead barriers of semi-infinite thickness for the primary radiation incidence angles $\theta_0 = 0, 30, 60, 85°$. It is seen that the calculated energy albedo values for aluminum are in good agreement with experimental data. For iron and lead barriers and $E_{\gamma max} > 10$ MeV, the experimentally determined albedo values exceed the calculated values; this discrepancy increases with the atomic number of the reflector. This discrepancy can be explained by the contribution of the processes not taken into account in calculations (the bremsstrahlung radiation of secondary electrons and interaction between γ quanta and nuclei), which plays a considerable role at medium and high energies. (TSS)

7438 SPECTRAL AND ANGULAR DISTRIBUTIONS OF BACKSCATTERED ^{137}Cs γ RAYS EMERGING FROM VARIOUS PARTS OF A REFLECTOR. Pichugin, A. V.; Pozdneev, D. B. This paper was summarized in At. Energ. (USSR); 28: 236(Mar 1970) as paper No. 375/5517. (In Russian).

Quantitative results are presented of an experimental study of the spectral and angular distributions of backscattered γ radiation from a point isotropic ^{137}Cs source in close contact with a graphite scatterer as a function of the distance r from the source to the point in question on the surface of the reflector. The data obtained are shown for angles of emergence θ of 15° and 60°, where θ is measured from the normal to the reflector surface at the point in question and is counted positive if the source and detector are on opposite sides of the normal and negative if they are on the same side. Differential energy spectra of reflected γ radiation for $\theta = -30°$ to $+60°$ in 15° steps and for distances r from 4 to 24 cm are presented. A physical explanation of the data obtained is given. The effect of cadmium and iron cladding on the spectral and angular spatial distributions of reflected γ rays was investigated. The differential energy spectrum for a graphite reflector covered with a 1-mm-thick cadmium layer is shown. (tr-auth)

7439 NEUTRON-SHIELDING QUALITIES OF WATER-EXTENDED-POLYESTERS. Oliver, G. D.; Moore, E. B. (Univ. of Texas, Houston). Health Phys.; 19: 578-80(Oct 1970).

Neutron attenuation comparisons of a new material, water-extended-polyester resin (WEP) with water, lucite, and polystyrene are given. WEP has qualities of easy preparation, high water content, solid form, and low cost and is fireproof which recommend its use for shielding structures. Such a storage shield designed to contain 54 ^{252}Cf sources totaling 200 μg is described. The shield weighs 600 lbs, and the measured dose on the side surface is 50 mrem/hr. (UK)

7440 GAMMA-RAY SPECTRA ARISING FROM FAST-NEUTRON INTERACTIONS IN ELEMENTS FOUND IN SOILS, CONCRETES, AND STRUCTURAL MATERIALS. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 42: 335-51(Dec 1970).

Measurements were made at the Tower Shielding Facility of the spectra of secondary gamma rays arising from fast-neutron interactions in samples of natural iron, aluminum, copper, zinc, titanium, potassium, calcium, sodium, silicon, nickel, barium, sulfur, and a type-321 stainless steel. The absolute spectra are expressed as values of $\bar{\sigma}(\Delta E_\gamma) = 4\pi\, d\bar{\sigma}/d\Omega\ (\Delta E_\gamma, 90\ deg)$, where $\bar{\sigma}(\Delta E_\gamma)$ is the production cross section in millibarns averaged over an incident neutron spectrum from 1 to 14 MeV for 0.5-MeV wide gamma-ray intervals lying between approximately 1 and 6.5 MeV in gamma-ray energy. These data are intended primarily as integral checks on existing and future production cross-section sets that are differential in both the gamma-ray and neutron energy. Agreement with existing sets of data is adequate for iron, nickel, chromium, calcium, and aluminum. The agreement is fair to poor for the remaining elements where comparisons could be made. (auth)

Solid-State Physics

Refer also to abstract 7789.

Radiation Effects

Refer also to abstracts 6596, 6882, 6883, 7137, and 7145.

7441 (CEA-CONF-1645) RADIATION DAMAGE FROM IMPLANTED IONS. Dautreppe, D. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1970. 26p. (CONF-700933-1). Dep. NTIS (U. S. Sales Only).

From Conference on Hyperfine Interactions detected by Nuclear Radiation, Rehovot and Jerusalem, Israel.

The different methods of performing ion implantation (nuclear reactions or excitation and direct implantation with an isotope separator), and the damages involved during the process were studied under the following headings: the slowing down of the primary, the distribution of the implanted ion, general considerations about the damage from nuclear collision, lattice effects, annealing of the damage, energy and dose effects, and the final position of the implanted ion. (France)

7442 (ORO-3651-6) DRIFT MOBILITY OF HOLES IN GERMANIUM BOMBARDED BY FAST NEUTRONS. Special Progress Report. Yeh, Ta Hai (Kentucky Univ., Lexington. Research Foundation). 1970. Contract AT(40-1)-3651. 135p. Dep. NTIS.

Thesis.

A study was made of the effect of fast neutrons on the electronic transport properties of semiconductors in general, and the effect on minority carrier drift mobility of n-type germanium in particular. In the disordered-region model for neutron damage in n-type germanium developed by Crawford, Cleland, and Gossick (1959), small highly p-type regions are formed in the n-type matrix. The p region is surrounded by a space charge zone, which shields it from the outside n-type lattice. The potential well thus

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formed suppresses majority carrier current, and at the same time, may, or may not, enhance minority carrier current depending on the extent of trapping by damage regions. The purpose of the present study is to explore the behavior of minority carriers and to determine, at least roughly, how this behavior is influenced by the presence of disordered regions. Measurements have been made of the hole drift mobility and dc resistivity versus temperature in n-type germanium which has been subjected to successive monoenergetic neutron irradiations. Material studied ranges from 1 to 16 ohm-cm; the temperature range covered is from 77 to 300°K; the energies of neutrons used for irradiation are 14 and 1 MeV; and the total neutron flux of irradiation is about 3×10^{12} n/cm^2. A modified version of the Haynes–Shockley experiment has been developed and employed for the drift mobility measurement. Results of measurements made with 14-MeV neutrons indicate that dc resistivity increases with irradiation in accord with the prediction of the theory of the disordered-region model, whereas the hole drift mobility shows a uniform monotonic decrease with irradiation, contrary to preliminary experimental studies and theoretical calculations in which trapping was neglected. There is clear evidence of the introduction of high concentration of trapping centers by neutron irradiations and the trapping effects are thought to be responsible for the decrease in hole drift mobility. The disordered-region model is extended in order to account for minority carrier behavior. Trapping states within the regions are considered, and a semiquantitative expression is presented for the drift mobility of minority carriers in neutron-irradiated semiconductors. The expression includes the effects of two competing processes, viz. the dipolar diffusion process due to the presence of the disordered regions and the trapping process due to the trapping states within the regions. The expression gives a qualitative explanation to the experimental observations obtained. (D.L.C.)

7443 (RT/FI–(70)28) ANALYSIS OF DEFECTS IN A LiF CRYSTAL IRRADIATED AT 77°K WITH A 1.5×10^{19} n/cm^2 DOSE OF THERMAL NEUTRONS. Diana, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 20 May 1970. 21p. (In Italian). Dep. NTIS (U. S. Sales Only).

The evolution of defects, for annealing temperatures up to 675°C, was studied with the technique of small-angle x-ray scattering. (auth)

7444 OPTICAL AND ELECTRICAL PROPERTIES OF Mn-DOPED KCl CRYSTALS. Mehendru, P. C.; Mitra, Ved (National Physical Lab., New Delhi). Indian J. Pure Appl. Phys.; 6: 350-3(1968).

In uncolored KCl crystals, Mn introduces two absorption bands at 201 and 273 nm with half-widths 0.36 and 0.15 eV, respectively. A new ultraviolet band at 223 nm is observed in the room-temperature x-irradiated KCl : Mn crystals, which was found to grow continuously up to 400 min of irradiation. Increase in the concentration of Mn enhances the peak values of the absorption bands at 223, 560, and 830 nm. However, in these doped crystals, the absorption under the F-band (560 nm) is always suppressed, whereas that under the M-band (830 nm) is always enhanced as compared with a pure crystal. Thermoluminescence measurements indicate that both the first- and the second-stage F centers are suppressed by the presence of Mn. This suppression is, however, least for the crystals containing the highest concentration of Mn. The value of S in the relation $\alpha_M = S.\alpha_F^2$ is found to be lower for KCl : Mn crystals. It is further found that the value of S is almost independent of the concentration of Mn. Measurements of electric conductivity made with KCl : Mn crystals gave the value of the activation energy for the migration of a cation vacancy as E = 0.72 eV and the energy of association of a cation vacancy with Mn ion as W_a = 0.54 eV. (auth)

7445 IMPLANTATION OF 10- TO 80-keV LITHIUM IONS IN DIAMOND. Galkin, V. V.; Krasnopevtsev, V. V.; Milyutin, Yu. V. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Semicond. (Engl. Transl.); 4: 709-16(Nov 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 837-46(May 1970).

The optical interference method was used to study crystal lattice defects generated in diamond by bombardment with 10- to 80-keV lithium ions, implanted in doses from 10^{14} to 10^{16} cm^{-2}. It was found that the doped region consisted of two layers with different refractive indices. The layer next to the surface contained most of the radiation defects and its thickness was governed by the range of unchanneled ions. The thickness of the second layer was several times greater, and it was related to the range of channeled ions. High-temperature treatment annealed the defects generated by small radiation doses and transformed strongly damaged diamond into graphite in the case of large doses. Under some conditions, an ionization region could be observed. The measured total conductivity profile was found to be in agreement with the interference data. (auth)

7446 FINE STRUCTURE OF THE RED CATHODOLUMINESCENCE BAND OF β SiC IRRADIATED WITH FAST ELECTRONS. Geitsi, I. I.; Nesterov, A. A.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 4: 744-9(Nov 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 879-85(May 1970).

An investigation was made of the cathodoluminescence of β SiC, which was associated with structure defects. Irradiation with fast electrons and heating to high temperatures (above 1100°C) stimulated the luminescence in the 6250- to 10,000-Å region. A fine structure in the form of narrow lines (of half-widths less than kT) and their phonon replicas was observed on the short-wavelength side of the cathodoluminescence band at temperatures below 150°K. It was found that the "red" band and its fine structure were most probably due to radiative annihilation of excitons captured by ionized centers, which were formed as a result of irradiation or heating at high temperatures. It was concluded that these centers were of the acceptor type. The fine structure of the cathodoluminescence yielded the depths of the levels of these centers: E_v+ 0.42, E_v+ 0.44, E_v+ 0.48, and E_v+ 0.5 eV. (auth)

7447 DISTRIBUTION OF THE CONCENTRATION OF PHOSPHORUS IN LAYERED SILICON STRUCTURES PREPARED BY ION IMPLANTATION. Evdokimov, V. M.; Kukharskii, A. A.; Strel'tsov, L. N.; Titov, V. B.; Khaibullin, I. B. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 4: 797-9(Nov 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 941-4(May 1970).

Si plates (cut parallel to (111) plane) were doped with P ions at 12.5 to 100 keV and annealed at 800°C. The depth distributions of the electric conductivity and reflection spectra were determined. The conductivity distributions indicated that the thickness of the doped layer depends on the energy, and that the layer is inhomogeneous at the lower energies. The reflection spectra after successive removal of surface layers were used to determine the distribution of the carrier density. The reflection coefficient in the 20- to 25-μ range was found to depend on the layer thickness. The dependence of the doped layer thickness on the energy can be described by a power law with an exponent 0.55. (D.L.C.)

7448 INFLUENCE OF NEUTRON IRRADIATION ON THE DIFFUSION OF ZINC IN INDIUM ARSENIDE. Boltaks, B. I.; Savin, E. P. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 4: 470-1(Sep 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 567-8(Mar 1970).

Single crystals of n-type InAs were irradiated with 5×10^{16} fast n/cm^2 at 150°C. Diffusion anneals with a Zn diffusion source were carried out at 800°C, and then the distribution of Zn was determined. The p–n junction was made visible by etching. The results show that the irradiation reduces the depth of the p–n junction by 60 μ, and that the diffusion is reduced, in agreement with the dissociative diffusion mechanism. (D.L.C.)

7449 EMF OF A SEMICONDUCTOR COATED WITH A FISSIONABLE MATERIAL. Agranovich, V. M.; Konobeev, Yu. V.; Lebedev, S. Ya.; Taurbaev, T. I. (Physics and Power Inst., Obninsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 4: 426-30(Sep 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 512-17(Mar 1970).

The generation of an emf in a semiconductor coated with a fissionable material and then bombarded with thermal neutrons was investigated experimentally. The short-circuit current of a silicon converter was calculated as a function of the neutron flux and the integrated dose. The calculated dependence was compared with the experimental data on the short-circuit current. (auth)

7450 KINETICS OF THERMAL ANNEALING OF RADIATION DEFECTS IN SILICON DOPED BY THE ION IMPLANTATION METHOD. Gusev, V. M.; Titov, V. V. Sov. Phys.-Semicond. (Engl. Transl.); 3: 1-6(Jul 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 3-10(Jan 1969).

The kinetics of the thermal annealing of radiation defects generated by implantation doping of silicon with boron and phosphorus ions was investigated by isochronous and isothermal methods. The isochronous annealing results obtained between 100 and 900°C showed that the annealing took place in three stages, whose presence and extent (on the temperature scale) depended strongly on the dopant dose. A tentative identification of the process responsible for the annealing was deduced. It was established that the activation energies of interstitial atoms were 0.34 ± 0.03 eV for phosphorus and 0.62 ± 0.06 eV for boron.

The isothermal annealing at 150 to 300°C showed that there were several competing processes at these temperatures. (auth)

7451 FORMATION OF RADIATION DEFECTS IN INDIUM ANTIMONIDE AT SUBTHRESHOLD RADIATION ENERGY. Vitovskii, N. A.; Vikhlii, G. A.; Galavanov, V. V.; Mashovets, T. V.; Khansevarov, R. Yu. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 3: 106-7(Jul 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 132-4(Jan 1969).

The effects of light illumination on the electrical properties (conductivity and hole density) of p-type InSb were investigated in comparison with x and gamma rays. The annealing curves revealed a stage at ~100°K for all three types of radiation, and this is attributed to the recombination of Frenkel pairs of In. Experiments, in which surface layers were ground away, showed that the thickness of the defect layer produced by light is greater than 30 μ. (D.L.C.)

7452 OSCILLATIONS OF THE PHOTOCURRENT IN Ge WITH RADIATION DEFECTS. Rubinova, E. E.; Novikov, S. R.; Konopleva, R. F. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 3: 1294-6(May 1970).

Translated from Fiz. Tekh. Poluprov.; 3: 1549-52(Oct 1969).

Slowly decaying low-frequency periodic oscillations of photocurrent were investigated in n-type Ge irradiated with fast neutrons or 660-MeV protons. The oscillations were observed only when the irradiation had lowered the Fermi level to near the middle of the forbidden band, in a minimum electric field. The frequency and modulation depth depended on the light intensity. The light-probe method was used to study the oscillations, which are attributed to the appearance of high-field domains moving under the action of an electric field. A mechanism for the creation of those domains is proposed. (D.L.C.)

7453 INVESTIGATION OF RADIATION-TYPE CENTERS GENERATED BY BOMBARDMENT OF A REAL GERMANIUM SURFACE WITH LOW-ENERGY He^+ IONS. Litovchenko, V. G.; Lysenko, V. S. (Inst. of Semiconductors, Kiev). Sov. Phys.-Semicond. (Engl. Transl.); 4: 56-62(Jul 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 72-9(Jan 1970).

The combined field effect was used to study some characteristics of radiation defects generated by bombardment with helium ions of relatively low energy (~0.5 to 5 keV). The surface and volume centers were distinguished. It was found that bombardment generated amphoteric surface centers which acted as traps in the investigated part of the forbidden band. These centers owed their existence to structure defects at the surface and their properties were similar to those of donor–acceptor pairs of point defects in the interior of a crystal. A deep recombination level, $E_{tc} \approx -0.22$ eV, had approximately the same parameters as a volume radiation-defect level: the difference was confined to their capture cross sections. Some conclusions are drawn about a model of the centers existing on a normal real surface. (auth)

7454 DISTRIBUTION OF RADIATION DEFECTS IN PROTON-IRRADIATED GALLIUM ARSENIDE. Okunev, V. D.; Mamontov, A. P.; Zakharov, B. G.; Azikov, B. S. Sov. Phys.-Semicond. (Engl. Transl.); 4: 80-3(Jul 1970).

Translated from iz. Tekh. Poluprov.; 4: 101-5(Jan 1970).

The electron-probe method was used to investigate the distribution of radiation defects in proton-irradiated gallium arsenide. The dependence of this distribution on the energy and integrated flux of protons was determined. The experimental data on the depth of penetration of protons were in good agreement with the calculated values. It was found that the change in the luminescence intensity caused by proton irradiation depended on the nature and concentration of the impurities in gallium arsenide. The change in the luminescence intensity observed for tellurium-doped crystals was attributed to the formation of $Ga_2V_{Ga}Te_3$-type complexes. (auth)

7455 LOW-TEMPERATURE IRRADIATION OF GERMANIUM WITH 28-MeV ELECTRONS. Abiev, A. K.; Ukhin, N. A. (Inst. of Physics, Baku, Inst. of Atomic Energy, Moscow). Sov. Phys.-Semicond. (Engl. Transl.); 4: 404-6(Sep 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 484-7(Mar 1970).

The Hall emf and the conductivity of n-type germanium (0.1 to 14 $\Omega \cdot$cm) were determined during irradiation with 28-MeV electrons at 88°K. The results obtained confirmed the formation of disordered regions. The Gossick model was used in the calculations, which yielded some parameters of the disordered regions. The most probable values of the average radius of these regions were within the limits 135 to 900 Å. The corresponding most probable values of the acceptor concentration were $N_A = 10^{17}$–10^{19} cm^{-3} and the threshold energies of the formation of these regions were $E_r = 15$–19.7 keV. (auth)

7456 VIBRATION SPECTRA OF LATTICE DEFECT–OXYGEN COMPLEXES IN SILICON IRRADIATED WITH FAST NEUTRONS. Lappo, M. T.; Tkachev, V. D. (Belorussian State Univ., Minsk). Sov. Phys.-Semicond. (Engl. Transl.); 4: 418-22 (Sep 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 502-7(Mar 1970).

An investigation was made of the infrared absorption in neutron-irradiated crystals of silicon with different concentrations of oxygen. A new absorption band, attributed to the presence of interstitial oxygen, was observed at 5.81 μ. Two models of the association of oxygen with silicon atoms were considered: oxygen in an interstice and oxygen at a vacancy. A calculation concerning triatomic nonlinear Si–O–Si "molecules" made it possible to determine the force constants and the angle between the two bonds in two types of molecule. It was found that only the optically active oxygen, responsible for the 9-μ band of the original material, participated in the formation of the absorption bands of the irradiated silicon crystals. (auth)

7457 THERMOLUMINESCENCE AND THERMALLY STIMULATED CURRENTS IN QUARTZ. Halperin, A.; Braner, A. A.; Shapira, J. (Hebrew Univ., Jerusalem). J. Lumin.; 1-2: 385-97(1970).

From International Conference on Luminescence, Newark, Del. See CONF-690840-(Vol.1 and 2).

Processes of excitation and recombination in quartz were investigated. Specimens were natural Brazilian and synthetic Ge-doped crystals. Excitation was by x rays or 5-MeV electrons. Thermoluminescence (TL) measurements included spectra of emission, bleaching, and re-excitation. Thermally stimulated currents (TC) and optical absorption were also measured. Most TL peaks were accompanied by TC peaks. Samples showing strong TL had generally weak TC, and vice versa. TL spectra of all samples showed a band at 370 nm. Some peaks, mainly at temperatures below 300°K, often emitted in the blue–green. TL peaks were bleachable optically, 300 nm light being most effective. TC peaks were unaffected by uv, indicating that luminescence centers and not trapped electrons were involved. TL peaks could be re-excited by uv light (290 nm). These and other results are discussed, and conclusions as to energy levels and transitions involved are drawn. (auth)

7458 DEFECT LUMINESCENCE IN IRRADIATED MgO. Chen, Y.; Kolopus, J. L.; Sibley, W. A. (Oak Ridge National Lab., Tenn.). J. Lumin.; 1-2: 633-40(1970).

From International Conference on Luminescence, Newark, Del. See CONF-690840-(Vol.1 and 2).

It has only recently been established that, in irradiated and additively colored MgO crystals, both the F^+ center (an oxygen-ion vacancy with one trapped electron) and the neutral F center (an oxygen-ion vacancy with two trapped electrons) absorb light near 5.0 eV. In these crystals excitation with 5.0-eV light or x rays produces an emission band at 3.13 eV, which can be correlated with ESR measurements of the F^+ center. In neutron-irradiated crystals, additional emission bands are observed that are attributed to defect cluster centers. In these crystals a luminescence band is found at 1.55 eV, which is due to the defect that produces the 2.16-eV absorption band. (auth)

7459 MECHANISM OF RECOMBINATION LUMINESCENCE OF ALKALI HALIDES DOPED BY Eu^{2+}. Parfianovich, I. A.; Shuraleva, E. I.; Ivakhnenko, P. S. (Irkutsk State Univ., USSR). J. Lumin.; 1-2: 657-68(1970).

From International Conference on Luminescence, Newark, Del. See CONF-690840-(Vol.1 and 2).

It is known that the ions of Eu^{2+} enter the lattice of alkali halides together with the cation vacancies. The complex $Eu^{2+}V_c^-$ is stable up to 200°C. It, at the same time, is the center of emission. It was found that there is an electronic recombination mechanism of the luminescence upon the stimulation with light from F or electronic activator bands in alkali halides doped by Eu^{2+}. Besides, it is stated that there is a mechanism of emission like that mentioned above in x-ray-induced and thermostimulated luminescence. The activator emission, which is characteristic of Eu^{2+} is observed in all kinds of luminescence. The special test result is that Eu^{3+} is not produced under x irradiation; hence, the activator must form the hole recombination centers that are needed for the production of the electronic recombination mechanism of the luminescence. The study of the spectral characteristics of the investigated crystals indicates that the hole activator centers are produced under x irradiation. These centers are observed in the induced absorption spectra in KI–Eu. If such centers are not observed in the crystal, photostimulated and thermostimulated luminescence does not take place. (auth)

XUM

7460 ANNEALING OF SINGLET AND TRIPLET QUENCHING CENTERS IN ANTHRACENE. Levinson, J.; Marrero, J.;Cobas, A.; Weisz, S. Z. (Puerto Rico Nuclear Center, Rio Piedras, Univ. of Puerto Rico, Rio Piedras). J. Lumin.; 1-2: 726-31 (1970).

From International Conference on Luminescence, Newark, Del. See CONF-690840-(Vol.1 and 2).

The annealing of singlet and triplet quenching centers introduced by gamma irradiation in an anthracene crystal is studied simultaneously. The crystal is illuminated with a 20-nsec duration light pulse from a Q-switched ruby laser. The intensity of the fluorescence due to two-photon absorption and the decay time of the delayed fluorescence is measured as a function of radiation dose. For doses larger than 5×10^2 rad, the triplet lifetime is reduced, hence changing the decay time of the delayed fluorescence. For doses larger than 3×10^5 rad, the singlet lifetime is also reduced, causing a reduction in the intensity. Approximately 50% of the induced triplet quenching centers can be annealed at annealing temperatures between 70 and 93°C. The possibility that the destruction of triplets is due to electrons trapped at lattice distortions is discussed. (auth)

7461 X-RAY LUMINESCENCE OF SOLID NOBLE GASES. Swyler, K. J.; Creuzburg, M. (Univ. of Rochester, N. Y.). J. Lumin.; 1-2: 842-50(1970).

From International Conference on Luminescence, Newark, Del. See CONF-690840-(Vol.1 and 2).

Crystals of Ar, Kr, and Xe, grown from the melt in plastic or quartz tubes, show weak light emission during irradiation with x rays. This luminescence consists of impurity and intrinsic contributions. It is called intrinsic if it is not suppressed by reduction of the impurity concentration. This consists mostly of broader bands between 2000 and 5000 Å that are temperature and radiation-dose dependent. Luminescence in solid Kr is attributed to two different centers. A tentative model for one of them is the V_K center, since noble-gas molecular ions are stable in free space and are not much affected by the crystal. Extensions of these luminescence measurements are discussed. (auth)

7462 SHAPE OF THE EPR SPECTRUM OF IRRADIATED ALKALI-SILICATE GLASSES. Zamotrinskaya, E. A. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 106-12(1968). (In Russian).

The EPR spectra of ^{60}Co γ-irradiated alkali-silicate glasses was scanned in the g-factor range 2000 to 2025. It was found that the shape of the spectrum for glasses with small alkali content may be represented by the shape of three superimposed lines that have the g-factor axial anisotropy. (tr-auth)

7463 ELECTRON-SPIN RESONANCE STUDIES OF IRRADIATED ALKALI-GERMANATE GLASSES AND CRYSTALLINE COMPOUNDS. Gopalarao, Nalamolu. Providence; Brown Univ. (1969). 102p. University Microfilms Order No. 70-8721.

Thesis.

All the samples received a gamma-irradiation dose of 2×10^7 R, and were investigated at X-band (9.1 GHz) and Ka-band (35.5 GHz) frequencies at ~77°K and ~170°K respectively. Preliminary studies indicated that the ESR spectra of irradiated potassium germanate glasses were better resolved than those of the other germanate glasses, but that the general features of the spectra were the same for all alkali-germanate glasses. So, the present work is confined to the potassium germanate system. In the glasses of low alkali oxide up to about 23 molar percent K_2O, a hole center and an electron center were observed. (The centers with g values less than g_e, where g_e is the free-electron g value, are called electron centers and the centers with g values greater than g_e are characterized as hole centers.) As the alkali oxide concentration is increased, two additional centers become evident, a second hole center and a second electron center. The relative intensities of these centers were found to be dependent on the amount of K_2O present. A concurrent study of the ESR centers in polycrystalline compounds of the same system was carried out. The same centers observed in the glasses were also observed in the compounds. Measurements of the ESR spin-Hamiltonian parameters were made. A numerical simulation of the line shapes was carried out with the assistance of a newly developed computer program and the experimental line shapes were successfully simulated using that program. The electron centers are attributed to electrons trapped at a bridging oxygen vacancy. The low-alkali glass hole centers are attributed to a hole trapped in an oxygen bridging two GeO_4 units or perhaps bridging a GeO_4 and GeO_5 unit. The high-alkali hole centers are also attributed to a hole trapped at an oxygen bridging two GeO_4 units or bridging a GeO_4 and a GeO_5 unit. (TSS) (Diss. Abstr. Int., B)

7464 CHANNELING PROTONS IN SINGLE CRYSTALS OF IONIC COMPOUNDS AND SEMICONDUCTORS. Shipatov, E. T.; Kononov, B. A. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 52-6(1968). (In Russian).

The energy distributions of protons, channeled through single crystals of NaCl, KCl, KBr, Si, and Ge at different angles relative to the crystallographic planes {100} and {110} are compared. Data are evaluated according to the percentage of particles channeled by each lattice, considering the relationships of the angle of incidence, chemical composition of the target, and proton energies. (tr-auth)

7465 CONDUCTIVITY OF CdS INDUCED BY INTENSIVE ELECTRON BOMBARDMENT. Bakun, F. I.; Britov, A. D.; Zarubin, P. V.; (and others). Sov. Phys.-Semicond. (Engl. Transl.); 3: 122-4(Jul 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 147-50(Jan 1969).

The nonequilibrium conductivity and luminescence of CdS, GaAs, and PbS excited by strong electron pulses at 300°K, were measured using contactless microwave measurements. The nonequilibrium conductivity of CdS showed a tail with fast and slow components, while the luminescence pulse followed the shape of the electron pulse. The fast and slow components of the conductivity decay are associated with the capture by local centers. (D.L.C.)

7466 FEATURES OF THE CHANGES IN THE PHYSICAL PROPERTIES OF VERY PURE p-TYPE Si SINGLE CRYSTALS UNDER THE INFLUENCE OF ^{60}Co γ-RAY IRRADIATION. Konozenko, I. D.; Semenyuk, A. K.; Khivrich, V. I.; Dobrokhotov, G. A. (Physics Inst., Kiev). Sov. Phys.-Semicond. (Engl. Transl.); 3: 130-1(Jul 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 155-6(Jan 1969).

The effects of γ rays on the carrier density and minority carrier lifetime of p-type Si were studied. The hole density at 300°K increased with irradiation, reaching saturation at a dose of 2.7×10^{16} quanta/cm^2. The hole mobility at 300°K was not changed by irradiation. The temperature dependences of the carrier density before and after irradiation indicated a level at $E_v + 0.27$ eV (probably a divacancy). The photoconductivity spectra indicated a level at $E_v + 0.45$ eV (vacancy + boron). The minority-carrier lifetime decreased with irradiation; annealing of the recombination centers occurs at 110 to 150°C. (D.L.C.)

7467 FORMATION OF THERMAL DONORS DURING γ-RAY IRRADIATION OF n-TYPE SILICON. Starchik, M. I. (Physics Inst., Kiev). Sov. Phys.-Semicond. (Engl. Transl.); 3: 128-9(Jul 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 153-4(Jan 1969).

The effects of ^{60}Co γ rays on the electrical conductivity and carrier density in P-doped Si with a conductivity of ~20Ω · cm. Irradiation at room temperature reduced the carrier density and produced two energy levels in the forbidden band at $E_c - 0.16$ and $E_c - 0.40$ eV. Heating to 300°C without irradiation produced a small increase in the carrier density, while the combination of heating and irradiation produced a much stronger increase. The $E_c - 0.16$ eV level is attributed to the formation of thermal donors (SiO_4), which is accelerated by heating. (D.L.C.)

7468 ENERGY SPECTRA OF RADIATION DEFECTS GENERATED IN Si BY DEUTERON IRRADIATION. Akimchenko, I. P.; Bulgakov, Yu. V.; Kolomenskaya, T. I. (Moscow State Univ.). Sov. Phys.-Semicond. (Engl. Transl.); 3: 132-3(Jul 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 157-9(Jan 1969).

The photoconductivity spectra of p-type Si crystals before and after irradiation with 12-MeV deuterons were studied. The irradiation produces structure in the impurity region of the spectrum, with levels at $E_v + 0.3$, $E_v + 0.37$, $E_v + 0.45$, and $E_c - 0.16$ eV. The results are identical to these for fast-electron irradiation. Irradiations of unshielded and shielded samples showed a new transition to a level at $E_v + 0.89$ eV ($E_c - 0.27$ eV). The results indicate that deuteron irradiation induces volume complexes of point defects and impurities which are similar to those induced by fast electrons. (D.L.C.)

7469 RADIATIVE RECOMBINATION IN GaSb EXCITED WITH AN ELECTRON BEAM. Kastal'skii, A. A.; Filatova, E. S.; Shreter, Yu. G. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 3: 134-6(Jul 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 159-61(Jan 1969).

A study was made of the luminescence spectra of n- and p-type GaSb excited by 20-keV electrons at 0.025, 0.5, and 2 A/cm^2. The strongest peaks were found at 0.74 and 0.80 eV and a kink or separate peak at ~0.81 to 0.82 eV. Some possible radiation mechanisms are discussed. The shift to shorter wavelengths for the higher n-type impurity concentration is explained as being due to filling of the higher minima of the conduction band and consequent screening of donor centers. (D.L.C.)

7470 RADIATION-INDUCED CHANGES IN THE COHERENT EMISSION FROM CdS CRYSTALS. Kaneev, M. A.; Mashchenko, V. E.; Niyazova, O. R. (Inst. of Nuclear Physics, Tashkent). Sov. Phys.-Semicond. (Engl. Transl.); 3: 645-7(Nov 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 760-3(May 1969).

The spontaneous and coherent A exciton radiation accompanied by the emission of one or two longitudinal optical phonons was studied for CdS excited by 65-keV electrons. The coherent radiation deteriorated with dose. Electron diffraction and neutron activation were used to study the radiation damage; cadmium-accumulation regions were discovered. (D.L.C.)

7471 ELECTRON DISPLACEMENT DAMAGE IN COBALT IN A HIGH VOLTAGE ELECTRON MICROSCOPE. Howe, L. M. (Chalk River Nuclear Labs., Ont.). Phil. Mag.; 22: 965-82(Nov 1970).

The results are reported of an investigation on the formation and growth of visible defects (believed to be interstitial dislocation loops) which were produced in cobalt at 300°K during observation in a 750-kV high-voltage electron microscope. Many of the features regarding the nucleation of the defects, the growth of the dislocation loops, and the extent of a surface denuded layer are consistent with that expected from a simple theory of loop formation. Using the onset of visible damage as a criterion, the displacement threshold energy was determined for various directions of incidence of the electron beam in both hexagonal close-packed and face-centered cubic cobalt. In the hexagonal close-packed case E_d = 23, 30, and 33 eV for incidence along ⟨11$\bar{2}$0⟩, ⟨10$\bar{1}$0⟩ and ⟨0001⟩ respectively, and in the face-centered cubic case E_d = 23 and 30 eV for incidence along ⟨110⟩ and ⟨100⟩ respectively. (auth) (UK)

7472 COLOR CENTERS ANNEALING AND THERMOLUMINESCENCE IN SODIUM SILICATE GLASS. Bettinali, C.; Granati, P. (Univ., Rome). Z. Phys. Chem. (Frankfurt); 70: 24-30 (Jul 1970).

The kinetics of thermal annealing and buildup of radiation-induced centers were studied in a sodium silicate glass. The rate of the decrease and increase of some optical and paramagnetic centers was compared with that of the luminescence emission. The activation energies E of the annealing of paramagnetic centers are very close to those of thermoluminescence emission (TL). The values of E found with the "thermal quenching method" are lower than those obtained from the initial rise method. The difference was explained on the basis of an interaction between positive and negative centers, when the concentration of trapped species increases. The buildup curves give for the TL a linear log–log relation, for optical and paramagnetic centers an intensity log of dose relation. Models for the explanation of this behavior are proposed. (auth)

Physical Properties

Refer also to abstract 6589.

7473 (NBS-TN-365-1) SURVEY OF ELECTRICAL RESISTIVITY MEASUREMENTS ON 8 ADDITIONAL PURE METALS IN THE TEMPERATURE RANGE 0 TO 273 K. Hall, L. A.; Germann, F. E. E. (National Bureau of Standards, Boulder, Colo.). Aug 1970. 85p. GPO $1.00.

Experimental electrical resistivity data for 8 pure metals are compiled, tabulated, and graphically illustrated for a temperature range of 0 to 273°K. The metals are Cd, Cr, Mn, Ti, W, V, Zn, and Zr. A section is prepared for each particular metal which includes references, brief comments concerned with preparation of sample, purity, and any other pertinent information, tabulated data, and graph. (auth)

7474 (NYO-2391-119) FAR-INFRARED PROPERTIES OF LATTICE RESONANT MODES. V. SECOND ORDER STARK EFFECT. MSC Report No. 1443. Clayman, B. P. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics. Simon Fraser Univ., Burnaby (British Columbia). Dept. of Physics); Kirby, R. D.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Aug 1970. Contract AT(30-1)-2391. 65p. Dep. NTIS.

Small electric field-induced frequency shifts have been observed for resonant modes associated with three defect systems. For NaI:Cl^-, the shifts have been used to measure the quartic anharmonic terms of the interionic potential of the impurity ion. For KBr:Li^+, the quartic anharmonic terms are found to be very small and a harmonic potential which includes a central barrier with the barrier height less than the zero-point energy of the oscillator is required to explain the experimental results. For NaCl:Cu^+ only an "on-center" resonant mode configuration is consistent with the experimental results. (auth)

7475 (RISO-215) PHYSICS DEPARTMENT ANNUAL PROGRESS REPORT, 1st JANUARY–31st DECEMBER 1969. (Danish Atomic Energy Commission, Risoe. Research Establishment). Feb 1970. 43p. Dep. CFSTI (U. S. Sales Only).

ALPHA PARTICLES—effects on metals at MeV energies
ANTIMONY—phonon dispersion relations
BISMUTH ISOTOPES Bi-207—electron conversion spectrum of
BRASS—ordering of beta-, long-range
DEUTERIUM—phonon energies in solid
DEUTERONS—effects on metals at MeV energies
GOLD—radiation damage in, MeV alpha-proton, deuteron, and helium-3-beam
HELIUM ISOTOPES He-3—effects of ions of, on metals at MeV energies
HOLMIUM—magnetic structure of
HOLMIUM ALLOYS & SYSTEMS—Er–Ho-base, magnetic structure of
—Ho-base–Tb, magnetic structure of
ION BEAMS—sputtering efficiency of heavy
IRON FLUORIDES FeF_2—magnon dispersion relations in symmetry directions
MAGNETIC MIRROR MACHINES—plasma production in puffatron
MANGANESE FLUORIDES—magnetic ordering in MnF_2 at transition temperature
METEOROLOGY—temperature profile measured in Kansas, summer 1968
NEUTRONS—scattering by magnetic materials
PLASMA—production in puffatron and Q-machine
PLATINUM—radiation damage in, MeV alpha-proton, deuteron, and helium-3-beam
PRASEODYMIUM—magnetic structure of
PROTONS—effects on metals at MeV energies
Q DEVICES—plasma production in
SHOCK WAVES—current-sheet speed in magnetically driven
SILVER—radiation damage in, MeV alpha-proton, deuteron, and helium-3-beam
SPUTTERING—efficiency of heavy ions
TERBIUM—magnetic structure of (D.L.C.)

7476 MAGNETIC AND THERMAL PROPERTIES OF $MnBr_2.4H_2O$ AND PRASEODYMIUM METAL. Stein, Richard Lincoln. Pittsburgh; Univ. of Pittsburgh (1969). 122p. University Microfilms Order No. 70-11,821.

Thesis.

High precision measurements of the magnetization and heat capacity of polycrystalline $MnBr_2 \cdot 4H_2O$ were determined in the liquid helium temperature region in applied magnetic fields to 30,000 gauss. The phase diagram for the antiferromagnetic-to-paramagnetic transition was obtained from the points of inflection in the derived values of the rate of change of the entropy with temperature (heat capacity data) and the rate of change of magnetization with temperature at constant applied magnetic field. The loci of these points of inflection are plotted in the H–T plane and exhibit an abrupt change in slope indicative of a spin-flop transition occurring along that portion of the sample having the easy axis aligned with the applied field. In addition, the magnetic and thermal properties of two spherical samples of praseodymium metal were determined over the temperature region from 1.2 to 4.2°K in magnetic fields to 40 kilogauss. The zero-applied-magnetic-field heat-capacity data indicate the existence of an anomaly centered about 3.4°K and an upturn below 1.4°K. The temperature of the small 3.4°K anomaly decreases as the field is increased. The temperature of the onset of the upturn as well as its magnitude increases as the magnetic field is applied. This behavior was exhibited by both samples; however, the absolute magnitude of the heat capacity differed between samples. The magnetization exhibited no unusual behavior at 3.4°K; however, the magnetic moment in a 5000-gauss applied field increased as the temperature decreased. A remnant moment was detected in one of the samples after the application of a magnetic field. The effect of impurities on the anomaly is discussed. (Diss. Abstr. Int., B)

7477 ENTROPY OF ORDERING IN SOME URANIUM COMPOUNDS. Grunzweig-Genossar, J. (Technion-Israel Inst. of Tech., Haifa). Solid State Commun.; 8: 1673-6(1 Nov 1970).

Calorimetric data on the magnetic entropy in certain ordering UX compounds are interpreted, using a model which assumes the presence of U^{4+} ions with a singlet ground state. The crystal field splittings are calculated and compared with splittings obtained from magnetic measurements. (auth) (UK)

7478 EFFECT OF MAGNETIC ORDERING ON THE PHOTOLUMINESCENCE OF EuS AND EuTe. Busch, G.; Streit, P.; Wachter, P. (Laboratorium fuer Festkoerperphysik, Zurich). Solid State Commun.; 8: 1759-63(1 Nov 1970).

The magnetic ordering semiconductors EuS and EuTe show a near-infrared photoluminescence similar to that already reported for EuSe. In both substances, an emission band of ~0.2 eV half width is found at temperatures below ~250°K. The luminescence is significantly influenced by either ferromagnetic or antiferromagnetic order and sensitive to a magnetic field near the magnetic ordering temperatures. On cooling, the emission of EuS is shifted towards longer wavelengths and quenched below T_c, while the emission of EuTe exhibits a blue shift and an increase in intensity below T_N. The dependence of the luminescence properties on magnetic ordering is interpreted in the localized magnetic polaron model already proposed for EuSe. (auth) (UK)

7479 POLARIZATION MODULATED MAGNETOREFLECTANCE IN EuSe AND EuTe. Pidgeon, C. R. (Massachusetts Inst. of Tech, Cambridge); Feinleib, J.; Reed, T. B. Solid State Commun.; 8: 1711-14(1 Nov 1970).

A technique of optical polarization modulation was used to study magnetic ordering effects in ferromagnetic EuSe and antiferromagnetic EuTe. It is found that at 1.5°K, the alignment of domains in EuSe saturates at H ~ 25 kOe, and the canted-to-ferromagnetic phase transition in EuTe occurs at H = 75 ± 2 kOe. (auth) (UK)

7480 MAGNETIC PROPERTIES OF BINARY RARE EARTH ALLOYS. Millhouse, Arthur Holmes. Blacksburg, Va.; Virginia Polytechnic Inst. (1970). 146p. University Microfilms Order No. 70-11,509.

Thesis.

Single-crystal samples of Ho–Dy, Er–Gd, Er–Tb, Er–Dy, and Ho–Er alloys were prepared using the strain-anneal technique. Neutron-diffraction studies of these samples were made from room temperature to 4.2°K to determine their magnetic structure properties. In most cases, a detailed study of the intensities of several important reflections were made as a function of temperature. The temperature dependence of the ordered atomic moment and its projections along the c axis and upon the crystal basal plane were calculated, using the magnetic structure models proposed for the pure metals. For the alloys, these models are found to be satisfactory. In the alloy systems Er–Tb, Er–Dy, and Ho–Er, the best agreement with the measured moment values is obtained by assuming that the Tb, Dy, or Ho moments are parallel to the Er moments within hexagonal layers at 4.2°K. This implies that the "multimoment" anisotropies dominate in these systems and that anisotropic exchange is probably an important source of the anisotropy. The observations made on the alloys appear to be generally explicable by the combination of exchange and anisotropy which has been used for the pure metals. The existence of a sinusoidal c-axis oscillation at a lower temperature than the helical configuration is not, however, predicted by molecular field theory arguments. (Diss. Abstr. Int., B)

7481 TRAPPING LEVELS AND TEMPERATURE DEPENDENCE OF CARRIER MOBILITY IN BORON. Dzhamagidze, Sh. Z.; Mal'tsev, Yu. A.; Shvangiradze, R. R. (Physical-Technical Inst., Sukhumi, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 3: 80-2(Jul 1969).

Translated from Fiz. Tekh. Poluprov.; 3: 105-8(Jan 1969).

An investigation of the thermally stimulated conductivity was used to determine the energy levels of electron trapping centers in β-rhombohedral boron: these levels were at 0.17 to 0.18 and 0.27 to 0.28 eV below the bottom of the conduction band. An estimate of the concentration of these traps gave 10^{14} cm^{-3} and the electron-capture cross section was found to be 10^{-23} cm^2. The temperature dependence of the conductivity of β-rhombohedral boron was investigated from −165 to −120°C, before and after illumination with light from the fundamental absorption region. These measurements established that the hole mobility increased exponentially with temperature. (auth)

7482 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON LUMINESCENCE, NEWARK, DELAWARE, AUGUST 25–29, 1969. Williams, Ferd (ed.). J. Lumin.; 1-2: 1-959(1970). (CONF-690840-(Vol.1 and 2)).

A total of 87 papers and reviews are presented under the following session topics: II–VI compounds; radiationless processes luminescence efficiency; edge emission in II–VI compounds; excitons II; luminescence centers; energy transfer; II–VI and III–V compounds; ionic crystals; lifetimes, luminescence intensities, and phonons; rare earth phosphors and condensed noble gases; cathodoluminescence and electric field effects. Indexes are included. Eight of the papers were abstracted for NSA. (D.L.C.)

For abstracts of individual papers see: 7147, 7457–7461, 7483, and 7484.

7483 INTERACTION OF EXCITED STATES IN URANYL SALTS. Tolstoi, N. A.; Abramov, A. P.; Abramova, I. N. (Leningrad State Univ.). J. Lumin.; 1-2: 330-40(1970).

From International Conference on Luminescence, Newark, Del. See CONF-690840-(Vol.1 and 2).

The nonlinear quenching of uranyl salts was investigated. Photo-induced time-stable quenching centers were found. These centers are produced by a biphotonic process but may be destroyed by only a single quantum. This new center allows one to understand in detail the nonlinear quenching. (auth)

7484 EXCITATION OF CRYSTAL FLUORESCENCE OF Rb^+ DUE TO CHANGE OF NUCLEAR CHARGE FROM ^{85}Kr TO Rb, WITHOUT DIRECT EXCITATION BY β^- PARTICLES. Luchner, K.; Micklitz, H. (Technische Hochschule, Munich). J. Lumin.; 1-2: 368-75(1970).

From International Conference on Luminescence, Newark, Del. See CONF-690840-(Vol.1 and 2).

By sudden change of nuclear charge of gaseous ^{85}Kr (β^--decay) the daughter ion is excited (monopole excitation) with a probability of some percent; by spectral analysis this monopole excitation was discriminated from direct excitation by charged particles; this new excitation was measured by detecting photons emitted from the decaying atomic states in delayed coincidence with β^- particles. In the investigation of such excitation in solid rare gases, observed changes in excitation probability, fluorescence spectrum, and lifetime are compared with the respective values in the free atoms. These changes can be understood by considering the polarization caused by the daughter-ion Rb^+, the admixture of ligand orbitals, and the recoil of Rb^+: Before the decay, the parent atoms occupy regular sites in the rare-gas crystal; by the recoil the daughter ions are fired into various directions and come to rest either in the original lattice site or in interstitial places. For these various positions, the spectral emission is different; in this way the influence of the surrounding solid on atomic levels and the displacement energies of the recoiling ion can be studied. (auth)

7485 RELATION OF LUMINESCENCE PROPERTIES AND THE GYROTROPY OF URANYL COMPOUNDS TO THEIR STRUCTURES. Burkov, V. I.; Kizel, V. A.; Krasilov, Yu.; Madii, V. A.; Alikhanova, Z. M. (Physical-Technical Inst., Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 34: 572-5(Mar 1970). (In Russian).

Investigations were conducted on dispersive rotation, dichroism, and luminescence polarization of single-crystal uranyl propionate, $MUO_2(C_2H_5COO)_3$, where M is Cs, Rb, NH_4, or K, from room to liquid-nitrogen temperatures. Electron transitions contributing to optical activity were selected. The greater magnitudes of circular dichroism and polarization of luminescence bands are explained anomalously. A scheme for electron levels of uranyl ions is proposed, which explains the polarization peculiarities of the absorption and luminescence spectra and the other experimental results. (tr-auth)

7486 AZIMUTHAL RELATIONS OF DEGREE OF POLARIZATION OF THE SEPARATE LINES IN THE LUMINESCENCE SPECTRA OF CRYSTALS OF URANYL COMPOUNDS. Volod'ko, L. V.; Komyak, A. I.; Posledovich, M. R. (Belorussian State Univ., Minsk). Izv. Akad. Nauk SSSR, Ser. Fiz.; 34: 567-71 (Mar 1970). (In Russian).

The spatial distribution of polarization of the most intensive lines in the luminescence spectra of uniaxial and biaxial crystals of uranyl compounds at liquid-nitrogen temperature was studied. Radiation corresponding to transitions from the first excited electron state to the vibrational sublevels of the main electron state of uniaxial crystals may be simulated by a plane electric oscillator oriented perpendicularly to the optical axis. For biaxial crystals, transitions to sublevel energies of fully symmetric valence-bond oscillations of UO_2^{2+} may be simulated by three-dimensional oscillators in which one direction prevails over two others. Transitions to sublevel energies of antisymmetric valence-bond oscillations of uranyl ions in biaxial, as well as in uniaxial crystals, may be simulated by plane oscillators, perpendicularly or linearly oriented. (tr-auth)

7487 LUMINESCENCE AND ABSORPTION SPECTRA OF CRYSTALS OF URANYL CHLORIDES IN POLARIZED LIGHT. Komyak, A. I.; Sevchenko, A. N.; Sidorenko, M. M. (Belorussian State Univ., Minsk). Izv. Akad. Nauk SSSR, Ser. Fiz.; 34: 576-81 (Mar 1970). (In Russian).

Luminescence and absorption spectra of cesium uranyl chloride crystals were studied in the range 16,000 to 27,000 cm^{-1}. In the luminescence spectrum the polarization order of the lines that belong to the intramolecular oscillations of the complex ion $(UO_2Cl_4)^{-2}$ was detected and measured. By using polarized light for analysis of the absorption spectrum, it was possible to select

in the structural region electron-vibrationally excited states. The frequencies of oscillations in the lower and upper excited electron states were compared. On the basis of the spectral analysis, an energy-level scheme of uranyl ions in cesium chloride crystals was constructed. (tr-auth)

7488 GANTMAKHER–KANER OSCILLATIONS AND CYCLOTRON DAMPING OF HELICON WAVES IN INDIUM. Carolan, James Francis Jr. College Park, Md.; Univ. of Maryland (1969). 151p. University Microfilms Order No. 70-12,918.
Thesis.

Experiments were performed in indium on the Doppler-shifted cyclotron resonance (DSCR) absorption of helicon waves and on the Gantmakher–Kaner (GK) oscillations. Measurements were made with the magnetic field direction, z, perpendicular to the (001), (100), (110), and (111) crystal planes. For the (001) and (111) planes, structure in the DSCR absorption was observed in the form of a helicon propagation window. The window results from a gap in the $(\partial A/\partial k_z)$ curve, where A is the area of an orbit in the plane perpendicular to z. A characteristic $(\partial A/\partial k_z)$ associated with this window was measured. For the (001), excellent agreement was obtained with the Fermi surface given by the orthogonalized plane wave (OPW) parameters. The success in this case is attributed to the fact that the absorption one is measuring is from a small section of the second zone of the Fermi surface which only exerts a very weak effect on the helicons. Absorption edges in the directions mentioned corresponding to much stronger resonances were also studied. As has been noted in the literature, it is much more difficult to extract Fermi surface information for such absorption regions. The dispersion relation was calculated assuming the Fermi surface to be cylindrically symmetric about the magnetic field direction. Reasonable agreement with the observed dispersion was obtained. The (110) plane represented a little different type of edge in that $(\partial A/\partial k_z)$ at the edge is peaked sharply. This behavior is qualitatively different than the $(\partial A/\partial k_z)$ curve assumed by Stanford and Stern for Al and Krylov for In. GK oscillations were observed for the (001) and (110) planes in the DSCR absorption region. An attempt was made to see them in the (100) case but without success. In the (001) case the oscillation is observed to change period abruptly as a function of the magnetic field. The period of the oscillations just below the helicon edge does not correspond to the extermal value of $(\partial A/\partial k_z)$ expected. The surface impedance was calculated numerically, and the observed period was reproduced approximately. The switching from one period to another was duplicated. However, not all the observed periods were reproduced. This is thought to be due to the cylindrical approximation to the Fermi surface in the calculations. For the (110) plane a period was observed which does not correspond to the extremal value of $(\partial A/\partial k_z)$ causing the helicon edge. This period is believed to be associated with a stationary point in $(\partial A/\partial k_z)$ which is well away from the extremum. (Diss. Abstr. Int., B)

7489 REDISTRIBUTION OF DISLOCATIONS UPON ANNEALING AND DEFORMATION IN MONOCRYSTALS OF GROUP VIA REFRACTORY METALS. Bykov, V. N.; Zakharova, M. I. Fiz. Metal. Metalloved.; 26: 696-700(Oct 1968). (In Russian).

The effect of annealing at temperatures up to 1600° for 100 hr in vacuum ($\sim 5 \times 10^{-5}$ mm Hg) and impact deformations in liquid nitrogen on the dislocation structure and the degree of perfection of the monocrystalline samples of chromium, molybdenum, and tungsten were studied. The parameters of structure, stability, the redistribution of dislocations in the annealing process were examined. In the deformation of molybdenum monocrystals in liquid nitrogen, the formation of new subgranular lattice boundaries and the passage of dislocations through the initial subgranular boundaries were observed. (M.H.R.)

7490 OPTICAL PROPERTIES OF CUBIC NIOBIUM–TITANIUM ALLOYS IN THE VISIBLE AND NEAR-INFRARED SPECTRAL REGIONS. Bol'shova, K. V.; Leksina, I. E. (Lebedev Inst. of Physics, Moscow). Fiz. Metal. Metalloved.; 29: 777-81(Apr 1970). (In Russian).

In the spectral region 0.40 to 2.6 μ the optical constant n, and κ, $(n - i\kappa$ — the complex refractive index) were measured for electropolished cubic β solutions of Nb–Ti (25, 52, and 85 at. % Nb) at room and liquid nitrogen temperatures. On the basis of this and the conduction electron characteristics of the indicated alloys, values for the light conductivity $\sigma(\hbar\omega)$ and the dielectric constant $\epsilon(\hbar\omega)$, associated with the interzone transitions were obtained. (tr-auth)

7491 MAGNETIC PROPERTIES OF METALLIC COMPOUNDS OF RHENIUM. Savitskii, E. M.; Khamidov, O. Kh.; Checherikov, V. I.; Shadrina, N. I. (Inst. of Metallurgy, Moscow). Fiz. Metal. Metalloved.; 26: 602-5(Oct 1968). (In Russian).

It was determined that the metallic compounds of rhenium of different structural types, formed with paramagnetic transition metals are paramagnetic. The paramagnetic susceptibility of these phases does not depend both on temperature in the range 77 to 293°K, and on the magnitude of the magnetic field strength in the limits 1000 to 7000 Oe. The metallic compounds of rhenium of the lambda-phase type, formed with ferromagnetic rare-earth metals, are ferromagnetic. It was determined that the intermediate phase in the iron–rhenium system of the sigma-phase type ($\beta - U$) is paramagnetic, and the superconducting transition temperature of this phase is 6.55°K. (tr-auth)

7492 ELECTRON CORRELATION IN THE CHEMISORPTION OF 5d ATOMS ON TUNGSTEN. Newns, D. M. (Cavendish Lab., Cambridge, Eng.). Phys. Rev. Lett.; 25: 1575-7(30 Nov 1970).

The chemisorption energy of an atom in the 5d series on a tungsten substrate is calculated on the basis of a two-center Hubbard model, for which the ground-state energy may be obtained exactly. The experimental data can be fitted with a choice of parameters consistent with independent estimates. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 6595 and 7854.

7493 HYPERFINE STRUCTURE IN TRIVALENT PLUTONIUM. Edelstein, N.; Mehlhorn, R. (Univ. of California, Berkeley). Phys. Rev., B; 2: 1225-9(1 Sep 1970).

The hyperfine structure constants of Pu^{3+} in CaF_2, SrF_2, and BaF_2 are analyzed and the values $\langle 1/r^3 \rangle = 7.57 \pm 0.57$ a.u. and $a_{c_{Pu^{3+}}} = -(556 \pm 42)(g_J - 1)(\mu_N/I)$ Mc/sec are derived. Relativistic Dirac–Slater and Dirac–Fock wave functions give a value for $\langle 1/r^3 \rangle$ about 9% lower than the empirical value. The core-polarization effect in the actinide ion Pu^{3+} is much larger than in the lanthanide series. (auth)

7494 NUCLEAR MAGNETIC RESONANCE OF PROTONS IN PLUTONIUM HYDRIDE. Cinader, G. (Soreq Nuclear Research Center, Yavne, Israel); Zamir, D.; El-Hanany, U.; Hadari, Z.; Degani, G. Solid State Commun.; 8: 1703-5(1 Nov 1970).

Proton spin–lattice relaxation times T_1 of $PuH_{2.62}$ were measured as a function of temperature in the range $116°K > T \leq 294°K$. T_1 is found to decrease sharply with decreasing temperature. The temperature dependence of T_1 changes from $T_1T = A(T - \theta_1)$ at high temperatures, to $T_1T = B(T - \theta_2)^2$ at low temperatures. From the temperature dependence of the spin–spin relaxation time T_2, the activation energy of hydrogen diffusion is obtained. (auth) (UK)

7495 BETTER APPROXIMATION TO THE DEBYE–WALLER FACTOR. Hardy, K. A.; Parker, F. T.; Walker, J. C. (Johns Hopkins Univ., Baltimore). Nucl. Instrum. Methods; 86: 171-2 (1970).

A new approximation to the integral $Q(Z) = \int_0^Z x dx/(e^x - 1)$, which occurs in the Debye–Waller factor, is presented. The approximation gives a maximum error of 1.65% when compared to more exact tabular factors in the range $Z = 0.1$ to $Z = \infty$. (auth)

Theory

Refer also to abstract 7321.

7496 QUANTUM THEORY OF NONSTATIONARY CONDUCTIVITY OF POLARONS IN SOME UNORDERED SYSTEMS. Klinger, M. I. (Semiconductor Inst., Leningrad). Dokl. Akad. Nauk SSSR; 193: 313-16(11 Jul 1970). (In Russian).

The polarons absorption of electromagnetic waves was examined theoretically in a three-dimensional, homogeneous nonstationary system, consisting of spatially and energetically nonequivalent centers of localized polarons. The polaron is considered as electron(hole) + lattice defect quasi particle with either a strong or a weak bond. Such processes are illustrated by the "impurity" type of conductivity, described by M. I. Klinger et al. The basic concept of processes based on sudden conductivity chains and local polarization currents in individual clusters of centers, corresponding to "polarization" conductivity are reviewed, deriving equations for the calculation of polaron conductivity. (TTT)

Theoretical Physics

Refer also to abstracts 6969, 7151, 7186, and 7193.

7497 (HUX-3780-27) DETERMINATION OF THE PHASES OF ELECTROMAGNETIC SCATTERING AMPLITUDES FROM

EXPERIMENTAL DATA. Gerber, R. B.; Karplus, M. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Chemical Physics). [1969]. 88p. Dep. NTIS.

The scattering of electromagnetic waves by systems of unknown charge distribution is considered, with the aim of establishing whether the phase of the scattered radiation (relative to incident one) can be computed theoretically from experimentally obtainable data, such as the intensity and the polarization of the scattered wave. The problem is to determine the phases of the scattering amplitude tensor from these data, and it is shown that this can be done by employing the unitarity relation of classical electromagnetic scattering theory. For the purpose of testing proposed methods for phase determination, the scattering of light by very simple systems was studied. These include the free electron, the H atom, and a macroscopic sphere of constant refraction index. The results obtained are very accurate. Using extremely crude approximations, the unitarity method is also applied to a molecular system to get an order-of-magnitude estimate of the phases. Finally, the possibility of applying the above results to the phase problem in x-ray scattering from amorphous and crystalline matter, and in light scattering from small macroscopic objects, is discussed. (M.O.W.)

7498 (JINR–P4-5351) APPLICATION OF THE STURM–LIOUVILLE FUNCTIONS FOR SOLUTION OF THE SCHROEDINGER EQUATION WITH THE ANISOTROPIC SAXON–WOODS POTENTIAL. Gareev, F. A.; Ivanova, S. P.; Shirikova, N. Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

A method is suggested for solution of the Schroedinger equation with anisotropic potential of finite depth for bound states $E < 0$. A single-particle wave function is represented as a superposition of the wave eigenfunction of the Sturm–Liouville problem. The problem of taking into account the effect of the continuous spectrum on the bound states is solved automatically. (auth)

7499 (SC-RR-70-664) SIMPLE METHOD OF CALCULATING NEUTRAL PARTICLE TRANSPORT PROPERTIES USING THE DISPERSION POTENTIAL. Fox, R. L.; Bernard, R. S. (Sandia Labs., Albuquerque, N. Mex.). Dec 1970. 28p. Dep. NTIS.

A method is presented for estimating all of the neutral particle transport coefficients required for flow field calculations. A dispersion potential is utilized for both polar and nonpolar interactions. Expressions for the transport coefficients in terms of mean square molecular radii are developed. A method of estimating the mean square molecular radii for both monatomic and polyatomic gases is given. Results obtained using this method are compared to experimental data and to results obtained using a more complicated potential. Transport coefficients obtained using this method agree with previous values to within a factor of two for all cases considered. (auth)

7500 CHARGED BOSE GAS. Lock, Abraham. New York; Yeshiva Univ. (1969). 84p. University Microfilms Order No. 70-11,610.

Thesis.

Using the Bohm–Pines (BP) and Bogolyubov formalisms as well as the random phase approximation, the investigation of the charged Bose gas is extended into the intermediate densities for which $r_s \lesssim O(1)$. The ground-state energy is essentially correlation energy, and is therefore negative. The expression for the plasmon spectrum does possess an energy gap; the single-particle excitation spectrum does not. Instead, the latter displays a quadratic dependence on the momentum at low values of the momenta; however, this latter spectrum differs from that of a noninteracting boson gas, as it gets diminished by two multiplying factors; the first arises from a mass correction term in the residual long-range-particle Hamiltonian and the second stems from the macroscopic occupation of the condensed state. Moreover, the expression for the single-particle excitation spectrum experiences a discontinuous jump at $k = k_c$. The finding concerning the absence of a gap in the single-particle excitation spectrum differs from those of Foldy and Chow and Lo and Wong, and it stems from the fact that the use of two consecutive BP canonical transformations separates out all but a residual component of the long-range Coulomb interaction from the particle Hamiltonian and effects the decomposition of the latter into BP elementary excitations; these elementary excitations assume the very same gap in the plasmon spectrum that Foldy obtained for his single-particle excitation spectrum, while retaining the full Coulomb interaction in the particle Hamiltonian. Finally, it is shown that the expression for the specific heat, C_v, vanishes in the limit when the temperature $T \to 0$, and moreover C_v approaches zero from above as $T \to 0$. The expression for the pressure persists in remaining negative for all $r_s \lesssim O(1)$ at zero temperature. (Diss. Abstr. Int., B)

7501 QUANTUM ELECTRODYNAMICAL TREATMENTS OF ATOMS INTERACTING WITH RADIATION FIELDS. Chang, Ching-sung. Pittsburgh; Univ. of Pittsburgh (1969). 94p. University Microfilms Order No. 70-11,811.

Thesis.

A full quantum electrodynamical treatment of atoms interacting with a radiation field is presented. The formalism is applied to the following two cases: (A) the interaction between two neutral atoms by means of the exchange of a virtual photon, and (B) the interaction of a bound electron with external radiation fields of finite intensity. In (A), the Bethe–Salpeter equation for this system is solved in the ladder approximation. In (B), the Feynman–Dyson formalism is used. (TSS) (Diss. Abstr. Int., B)

7502 GENERALLY COVARIANT NONDIVERGENT EQUATIONS OF MOTION OF A CHARGED PARTICLE. Illman, Barry Leeds. Clemson, S. C.; Clemson Univ. (1969). 114p. University Microfilms Order No. 70-6274.

Thesis.

A derivation of the equations of motion (including self-field effects) of a charged particle was found in which divergent terms, and the subsequent mass renormalization, are conspicuously absent. All fields, including the gravitational field of the particle, must satisfy the Einstein–Maxwell field equations, which are derivable in the usual manner from a variational principle. The invariance of the action integral under infinitesimal co-ordinate transformations and the existence of the field equations leads to a surface integral independent of the surface parameters. By choosing a surface which surrounds, but does not enclose, the world line the surface integral is evaluated and the generally covariant equations of motion are obtained. An investigation of the surface integral suggests that the self-energy stored in the Coulomb field is just balanced by the particle's metrical field. (Diss. Abstr. Int., B)

7503 GREEN'S FUNCTION TECHNIQUE FOR DEALING WITH BOUNDARY-VALUE PROBLEMS OF THE LINEAR TRANSPORT THEORY. Kanal, Madhoo. Ann Arbor, Mich.; Univ. of Michigan (1969). 119p. University Microfilms Order No. 70-14,560.

Thesis.

In a recent paper by K. M. Case, a fresh approach was introduced to deal with boundary-value problems of linear transport theory. It draws on analogy with the Green's function technique in classical boundary-value problems such as electromagnetic theory, etc. In this work, the new approach is used to solve some boundary values of one-speed and energy-dependent transport theory. In the one-speed approximation, solutions are obtained to the following problems: the anisotropic half-space problems involving the determination of the neutron angular density as a function of the unit velocity vector; the spherically symmetric problems such as albedo, critical, and Milne problems for the interior of a sphere; and the Milne problem for the exterior of a black sphere. For the energy-dependent case, Boltzmann's integro-differential equation is considered for the Kac model. Only the heat flow and the Couette flow problems involving an infinite wall or two infinite parallel plates are studied. The basic procedure, however, is kept sufficiently general so that the extension to problems involving other geometries remains straightforward. (Diss. Abstr. Int., B)

7504 ONE CONCEPT OF INTEGRAL LOSS OF ENERGY OF CHARGED PARTICLES BY VAVILOV–CHERENKOV RADIATION IN SINGLE AXIS GYROTROPIC CRYSTALS. Kukanov, A. B. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 47-54(1970). (In Russian).

A new concept is presented for the integral energy losses of a charged particle by Vavilov–Cerenkov radiation in a single-axis gyrotopic crystal for the case in which the particle moves at an angle to the optical axis that is different from zero. Certain cases were examined in which integration of the variables for the wave number regions up to the end of analytical relevance could be carried out. (tr-auth)

7505 BOUNDEDNESS OF THE SOLUTION AND THE SINGULARITY OF THE STOERMER PROBLEM. Moser, J. (New York Univ., N. Y.). Celestial Mech.; 2: 334-8(Oct 1970).

The motion of a charged particle in a dipole field was studied. In particular, the motion in the neighborhood of the singularity is investigated, and the topological nature of the flow near the dipole is resolved. (M.O.W.)

7506 COMMENT ON THE SYNCHROTRON MOTION WITH RADIATION DAMPING. Shen, C. S. (Tsing Hua Univ., Hsinchu, Taiwan). Phys. Lett.; 33A: 322(16 Nov 1970).

It is shown that the radiation from a relativistic charged particle in a magnetic field draws its energy from both the transverse and the longitudinal components of the motion. (auth)

7507 SOME PROBLEMS IN POTENTIAL THEORY. Levine, Harold (Stanford Univ., Calif.). Philips Res. Rep.; 25: 207-22(Aug 1970).

The advantages of utilizing Green's functions rather than superposing simple source functions or employing direct integral-representation and transform techniques for potential theory problems are discussed. (auth)

7508 INFINITUDE OR FINITENESS OF THE NUMBER OF BOUND STATES OF AN N-BODY QUANTUM SYSTEM. I. Simon, Barry (Princeton Univ., N. J.). Helv. Phys. Acta; 43: 607-30(1 Oct 1970).

A general discussion is given of when an N-body quantum system with two-body forces will have infinitely many bound states. A physically-motivated criterion for infinitude is presented and proved sufficient. In a restricted class of cases, it is proven to be necessary. Two applications are made: first, the Zhislin and Zhislin–Sigalov results on the number of bound states of atoms; secondly, the coupling constant dependence of the number of bound states and one finds it very different from the two-body situation. Finally, examples are presented of N-body systems with infinitely many bound states even though the two-body forces are too weak to bind any states. (auth)

7509 NUMERICAL EVALUATION OF THE SLAB ALBEDO PROBLEM SOLUTION IN ONE-SPEED ANISOTROPIC TRANSPORT THEORY. Kaper, Hans G.; Shultis, J. Kenneth; Veninga, Jaap G. (Univ. of Groningen, Netherlands). J. Comput. Phys.; 6: 288-313(Oct 1970).

The normal mode expansion technique is employed to obtain numerical results for the solution of the slab albedo problem in one-speed transport theory with anisotropic scattering. Methods are presented by which one may compute the angular distribution of particles anywhere in a slab of finite thickness for any degree of anisotropy of the scattering function. Many numerical examples are given and, from these examples, it is demonstrated how the slab albedo problem solution varies with the problem parameters, viz., the degree of anisotropy of the scattering function, the angle of incidence of the source beam, the slab thickness and the multiplication factor. (auth)

7510 CIRCULAR MODEL FOR AN INTERACTING FERMI GAS. Witteles, Eleonora Meira. New York; Yeshiva Univ. (1969). 228p. University Microfilms Order No. 70-11,612.

Thesis.

An interparticle potential having the properties that its Fourier transform has a functional form $(-)^k/k^2$, and whose spatial form is such that it can be solved exactly in the thermodynamic limit using the Green's function technique is studied. The results obtained from such an exact solution are compared with the conclusions reached by studying the problem using the RPA approximation, ordinarily used for the study of three-dimensional systems. It turns out, however, that the RPA breaks down for the model system. A further approximation is, therefore, made (which is called the Modified Random Phase Approximation (MRPA)). The study of the system in the MRPA shows that a first order phase transition is possible. The thermodynamic properties of the system and the question of the possibility of a first order phase transition is also studied in the exact solution of the model system. Upon further study of the circular one-dimensional model within the MRPA and using the BCS simplification and the BCS ansatz for the trial function for the system, it is shown that the system exhibits superconductive behavior in the sense that the existence of an energy gap in the single-particle energy spectrum is shown. The existence of a critical magnetic field and a discontinuity in the specific heat for the system is shown, i.e., the existence of a second-order phase transition. (Diss. Abstr. Int., B)

7511 DIFFERENTIAL-SPACE QUANTUM THEORY. Ochs, W. (Univ., Munich). Helv. Phys. Acta; 43: 668-84 (1 Oct 1970). (In German).

Differential-space quantum theory reformulates quantum mechanics as a theory with hidden variables. In this new theory, all observables of a physical system have well-defined values that change in a deterministic way. In analogy to statistical mechanics, a quantum-mechanical state (here regarded as a macrostate) is represented by an ensemble of microstates with an appropriate probability distribution. A simplified presentation of differential-space quantum theory and the underlying mathematics is given. (auth)

7512 ANALYSIS OF DIFFERENTIAL-SPACE QUANTUM THEORY. Ochs, W. (Univ., Munich). Helv. Phys. Acta; 43: 685-92(1 Oct 1970). (In German).

An analysis of differential-space quantum theory (DSQ) is given, continuing a former presentation of this theory. The investigation reveals (1) contradictions between the mathematical formalism of DSQ and the properties of an ensemble theory, and (2) quantitative differences between quantum mechanics and DSQ in the description of the measuring process. (auth)

7513 MULTI-COULOMB-TYPE EQUATIONS AND A NEW EXPANSION OF THE SCATTERING AMPLITUDE. Azzarelli, Teodoro. Los Angeles; Univ. of California (1969). 159p. University Microfilms Order No. 70-14,256.

Thesis.

A general type of O(n + 1) and O(n, 1) invariant equations, in the n-dimensional Euclidean space, are studied and solved, using properties of the generators and Casimir operators of their invariance groups. These equations and their solutions are investigated, first in momentum space, and then in x space, where they are shown to be multi-Coulomb type equations, namely: $(p_\beta^2 - \nabla_n^2)^\beta \psi(x) = (g/r^\beta)\psi(x)$. The above equation contains, as special cases, both the Schroedinger ($\beta = 1$, $n = 3$) and the Wick-rotated Bethe–Salpeter ($\beta = 2$, $n = 4$) equations for the Coulomb potential. A simple expression for the eigenvalues of the equation is obtained, for arbitrary values of β; but the eigenfunctions can be expressed in terms of known functions, only for $\beta = 1$. However, several properties, including orthogonality and completeness relation, are obtained for general values of β. The equation is investigated also for more general potentials, both local and nonlocal, and it is shown that there exists a set of nonlocal potentials for which the equation is still solvable. Local, nonsolvable, potentials are also introduced, and a perturbation analysis is carried for Yukawa type potentials. The possibility of extending the above formalism to the scattering problem, for the Schroedinger equation was investigated. This is shown (Finkelstein and Levy) to lead to some interesting results, for the case of the Coulomb potential, and also for a class of solvable potentials (Casimir potentials). (Diss. Abstr. Int., B) (TSS)

7514 STATISTICAL INTERPRETATION OF QUANTUM MECHANICS. Ballentine, L. E. (Simon Fraser Univ., Burnaby, B. C.). Rev. Mod. Phys.; 42: 358-81(Oct 1970).

The statistical interpretation of quantum theory is formulated for the purpose of providing a sound interpretation using a minimum of assumptions. Several arguments are advanced in favor of considering the quantum state description to apply only to an ensemble of similarly prepared systems, rather than supposing, as is often done, that it exhaustively represents an individual physical system. Most of the problems associated with the quantum theory of measurement are artifacts of the attempt to maintain the latter interpretation. The introduction of hidden variables to determine the outcome of individual events is fully compatible with the statistical predictions of quantum theory. However, a theorem due to Bell seems to require that any such hidden-variable theory which reproduces all of quantum mechanics exactly (i.e., not merely in some limiting case) must possess a rather pathological character with respect to correlated, but spacially separated, systems. (auth)

7515 IRREGULAR SOLUTION OF A SYSTEM OF COUPLED SCHROEDINGER EQUATIONS. Hategan, C. (Inst. for Atomic Physics, Bucharest). J. Comput. Phys.; 6: 333-5(Oct 1970).

Analytical formulas are derived for the irregular solution of the system and its derivative. As examples of application of these formulas, the irregular solution for the optical model equation and the irregular Coulomb function and their derivatives are derived. (M.O.W.)

7516 COMPUTATIONAL METHODS IN PHYSICS AND MECHANICS: PROBLEMS AND PERSPECTIVE. Dorodnicyn, A. A. pp 667-71 of Proceedings of the Fourth Australian Computer Conference, Adelaide, South Australia, August 11–15, 1969. Vol. 2. Adelaide; Australian Computer Society Inc. (1969).

See CONF-690837–(Vol.2).

Multidimensional problems, such as those of quantum mechanics are considered. If the equations of physics were arbitrary systems, the contradictory requirements of speed and accuracy in their solution would be, in principle, unsolvable. The laws of conservation of mass, energy etc., imply a continuity that can be exploited for a hundredfold increase in efficiency. The method of "integral relations," where a slowly changing solution for a physical process can be approximated to sufficient accuracy by solution of relatively low-order systems of equations, solves a number of practical problems. By expanding a complex computational operator into a sequence of lower-order operators, the accuracy can be improved to the same order as achieved by finite-difference methods. The combined efficiency of computers and mathematical methods is anticipated to increase about a hundred thousand times by the end of the century. (Australia)

XUM

7517 CALCULUS FOR FUNCTIONS OF NONCOMMUTING OPERATORS AND GENERAL PHASE-SPACE METHODS IN QUANTUM MECHANICS. I. MAPPING THEOREMS AND ORDERING OF FUNCTIONS OF NONCOMMUTING OPERATORS. Agarwal, G. S.; Wolf, E. (Univ. of Rochester, N. Y.). Phys. Rev., D; 2: 2161-86(15 Nov 1970).

A new calculus for functions of noncommuting operators is developed, based on the notion of mapping of functions of operators onto c-number functions. The class of linear mappings, each member of which is characterized by an entire analytic function of two complex variables, is studied in detail. Closed-form solutions for such mappings and for the inverse mappings are obtained and various properties of these mappings are studied. It is shown that the most commonly occurring rules of association between operators and c-numbers (the Weyl, the normal, the antinormal, the standard, and the antistandard rules) belong to this class and are, in fact, the simplest ones in a clearly defined sense. It is shown further that the problem of expressing an operator in an ordered form according to some prescribed rule is equivalent to an appropriate mapping of the operator on a c-number space. The theory provides a systematic technique for the solution of numerous quantum-mechanical problems that were treated in the past by ad hoc methods, and it furnishes a new approach to many others. This is illustrated by a number of examples relating to mappings and ordering of operators. (auth)

7518 CALCULUS FOR FUNCTIONS OF NONCOMMUTING OPERATORS AND GENERAL PHASE-SPACE METHODS IN QUANTUM MECHANICS. II. QUANTUM MECHANICS IN PHASE SPACE. Agarwal, G. S.; Wolf, E. (Univ. of Rochester, N. Y.). Phys. Rev., D; 2: 2187-2205(15 Nov 1970).

In Paper I of this investigation a new calculus for functions of noncommuting operators was developed, based on the notion of mapping of operators onto c-number functions. With the help of this calculus, a general theory is formulated, of phase-space representation of quantum-mechanical systems. It is shown that there is a whole class of such representations, one associated with each type of mapping, the simplest one being the well-known representation due to Weyl. For each representation, the quantum-mechanical expectation value of an operator is found to be expressible in the form of a phase-space average of classical statistical mechanics. The phase-space distribution functions are, however, not true probabilities, in general. The phase-space forms of the main quantum-mechanical equations of motion are obtained and are found to have the form of a generalized Liouville equation. The phase-space form of the Bloch equation for the density operator of a quantum system in thermal equilibrium is also derived. The generalized characteristic functions of boson systems are defined and their main properties are studied. The equations of motion for the characteristic functions are also derived. As an illustration of the theory, a generalized stochastic description of a quantized electromagnetic field is obtained. (auth)

7519 CALCULUS FOR FUNCTIONS OF NONCOMMUTING OPERATORS AND GENERAL PHASE-SPACE METHODS IN QUANTUM MECHANICS. III. A GENERALIZED WICK THEOREM AND MULTITIME MAPPING. Agarwal, G. S.; Wolf, E. (Univ. of Rochester, N. Y.). Phys. Rev., D; 2: 2206-25(15 Nov 1970).

The new c-number calculus for functions of noncommuting operators, developed in Paper I and employed in Paper II to formulate a general phase-space description of boson systems, deals with situations involving equal-time operators only. Extensions are presented for the treatment of problems involving boson operators at two or more instants of time. The mapping of time-ordered products onto c-number functions is studied in detail. The results make it possible to evaluate time-ordered products of boson operators by phase-space techniques. The usual Wick theorem for boson systems is obtained as a special case of a much more general theorem on time ordering. This method of derivation appears to provide the first direct proof of Wick's theorem as well as a clear insight into its true meaning. A closed expression is also obtained for the time-evolution operator in terms of the solution of the c-number differential equation for the phase-space equivalent of this operator. The new calculus is also applied to the problem of evaluating normally ordered time-ordered, and also the antinormally ordered time-ordered, correlation functions. (auth)

7520 RADIATION TRANSPORT IN PLANE AND SPHERICAL MEDIA. Smith, Owen James. Raleigh, N. C.; North Carolina State Univ. (1969). 143p. University Microfilms Order No. 70-9169.

Thesis.

Approximate and exact methods are applied to several transport problems in spherical geometry and to an example of radiative transfer in plane geometry. The approximate method considered develops first-flight angular flux kernels for two geometrical models: a finite spherical region containing a central zone that is black to incident radiation and an infinite homogeneous spherical medium. The homogeneous-medium kernels are used in conjunction with the method of successive generations to develop the first and second generation angular flux and particle density resulting from a point source in an infinite isotropically scattering medium. The black-sphere kernels are used to formulate an analytical expression and to calculate the first-flight escape probabilities for various annulus sizes. An exact solution for the half-space Green's function of the matrix transport equation describing the flow of polarized radiation in a free-electron atmosphere is determined. The singular-normal-modes expansion technique is used to construct the solution, and the expansion coefficients are determined by applying the proper boundary conditions. The necessary completeness and orthogonality theorems are proved; thus, all expansion coefficients are found by simply taking scalar products. The albedo problem for a semi-infinite half-space, in addition, is solved explicitly. Exact solutions to the integral transport equations for the particle density are sought for several problems in spherical geometry. A transform technique is used in each case to reduce the integral equation to an integro-differential equation amenable to solution using Case's method of normal modes. The problems considered are the finite-medium shell-source problem; the two-region (concentric-spheres) critical problem, in which a common total cross section is assumed, but different multiplication properties in the two zones are allowed; and the spherical Milne problem. Each analysis leads to an integral equation for the only unknown expansion coefficients, and these results are analyzed in the light of various approximations to the Fredholm equation. (auth)

7521 RELATIVISTIC CORRECTION TO THE EQUILIBRIUM STATISTICAL MECHANICS OF A DENSE ELECTRON GAS. Dengler, Terrance E. (Univ. of Vermont, Burlington); Krizan, John E. Phys. Rev., A; 2: 2388-95(1 Dec 1970).

The grand partition function for a degenerate electron gas with relativistic corrections of order $(v/c)^2$ in ring approximation is given. The technique used is the method of Montroll and Ward; in this problem independent field degrees of freedom are not required. The correlation energy, which represents a generalization of the Gell-Mann-Brueckner result, is obtained. Comparison with the field-theoretic results of Akhiezer and Peletminskii is made, with the same results. However, in view of the absence of independent field degrees of freedom in the treatment, renormalization is not required here (to obtain their result Akhiezer and Peletminskii must resort to charge, mass, and vacuum renormalization). (auth)

7522 TIME-DEPENDENT HARMONIC OSCILLATOR. Salusti, E. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Zirilli, F. Lett. Nuovo Cim.; 4: 999-1003(21 Nov 1970).

An approach based on a generalization of Dirac's method is considered for the problem of the quantum harmonic oscillator with a coupling constant K(t), which is a function of time. An operator $A(x, \partial/\partial x, t)$ with the property that, once applied to a solution of the Schroedinger equation gives another solution, is introduced. An explicit solution of the time-dependent Schroedinger equation is found as a simple generalization of the vacuum wave equation. An explicit form for a set of solutions is also found. (C.E.S.)

7523 SPECTRAL WEIGHT FUNCTION AND ELECTRON MOMENTUM DISTRIBUTION IN THE NORMAL ELECTRON-PHONON SYSTEM. Shimojima, Kiyoko; Ichimura, Hiroshi (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto); 43: 925-41(Apr 1970).

A detailed calculation for the interacting electron-phonon system is carried out by using the double-time Green's function method. The self-energy part and then the spectral weight function of the electron Green's function are given in detail to the second order of electron-phonon interaction. The effects of the interaction on the chemical potential of the electron and the Fermi momentum of the electron distribution are investigated. The average electron momentum distribution at zero temperature is evaluated in an approximation which may be considered as a simplification of the Migdal approximation. The amount of the discontinuity at the Fermi momentum is obtained and the numerical results show that there is a distinct modification of the electron distribution near the Fermi momentum due to the presence of the electron-phonon interaction. (auth)

7524 EXISTENCE OF THE SCHWINGER FUNCTIONAL IN QUANTUM MECHANICS. Sohr, H. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 25a: 804-15(Jun 1970). (In German).

In field theory use is made of functional calculus in increasing units. Examples are the S-matrix tneory and the theory of the Schwinger functional. Chiefly, these formalisms are used only theoretically, without convergence investigations. The convergence and the existence of the Schwinger functional are demonstrated as infinite time-ordered operator products for a class of a system of quantum mechanics. Such systems, e.g., the anharmonic oscillator, are used in field theory chiefly for model investigations. (tr-auth)

7525 HELICITY REPRESENTATIONS OF THE COORDINATE, MOMENTUM, AND ANGULAR MOMENTUM OPERATORS.

Moses, Harry E. (Air Force Cambridge Research Labs., Bedford, Mass.). Ann. Phys. (New York); 60: 275-320(Oct 1970).

After proving that all Hermitian realizations of the operators X_i, P_i, J_i are unitarily equivalent to realizations in which S_i, P_i have the usual Schrödinger form and J_i can be written as the sum of the orbital angular momentum L_i and "spin" S_i, realizations of these operators are given in which the helicity operators $X \cdot J$ and $P \cdot J$ are diagonal. Of particular interest are the angular momentum representations in which X^2, J^2, J_3, and $X \cdot J$ and P^2, J^2, J_3, and $P \cdot J$ are diagonal for particles of arbitrary spin. Applications of these angular momentum representations are discussed. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 7563.

7526 QUARK SEARCH USING A 1-MV MASS SEPARATOR AND PULSE-HEIGHT ANALYSIS. Nielsen, Kurt Efraim. Madison, Wis.; Univ. of Wisconsin (1970). 225p. University Microfilms Order No. 70-8321.

Thesis.

A search was made for stable particles of fractional charge $\pm 1/3$ e and $\pm 2/3$ e. It was suggested that all baryons and mesons are constructed from these particles, called quarks. A description is given of the methods used to detect quarks existing either as new chemical elements or in combination with the known elements. A mass separator has been developed to simultaneously measure the mass and energy of ions present in various beams accelerated by an electrostatic generator operating at 1 MV. A series of parallel field and electrostatic analyzers were employed to remove background caused by ion interaction with residual gases and beam apertures. Charge was measured by means of energy determination using a surface barrier detector and pulse height analysis. Helium, hydrogen, nitrogen, oxygen, air and limestone were examined. Data are exhibited and, from the null results, upper limits were determined for the concentration of quarks in the samples studied. These limits were on the order of 3×10^{-14} quarks/molecule. (Diss. Abstr. Int., B)

Electromagnetic

7527 (DESY-70/54) SMALL MOMENTUM TRANSFER π^+ PRODUCTION WITH LINEARLY POLARIZED PHOTONS. Burfeindt, H.; Buschhorn, G.; Geweniger, C.; Heide, P.; Kotthaus, R.; Wahl, H.; Wegener, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Oct 1970. 5p. Dep. NTIS (U. S. Sales Only).

Previous measurements of the cross section asymmetry for single π^+ production on protons with linearly polarized photons of 3.4 GeV were extended to momentum transfers within the forward peak, i.e., $-t = 0.0026$, 0.006 and 0.01 $(GeV/c)^2$. The results are in good agreement with pion exchange models. (auth)

7528 MEASUREMENT OF THE ENERGY AND ANGULAR DEPENDENCE OF THE EXTERNAL BREMSSTRAHLUNG ASYMMETRY. Penczynski, P. E.; Wehner, H. L. (Univ., Erlangen-Nuernberg, Ger.). Z. Phys.; 237: 75-85(1970). (In German).

In order to obtain an azimuthal dependence of the external bremsstrahlung produced by electrons, the electron beam has to be transversely polarized. In first-order Born approximation the differential cross section does not depend on the azimuthal angle Φ; but the second-order approximation includes the spin vector of the electrons and yields, consequently, a Φ dependence. A measurement of the bremsstrahlung asymmetry as a function of the photon energy and the emission angle Θ is described. The transversely polarized electron beam was produced by momentum deflection of longitudinally polarized β-decay electrons emitted from a ^{90}Sr source. With a kinetic energy of 300 ± 10 keV and a degree of transverse polarization of 74%, the electrons hit a Pb target. Because of the high γ background it was necessary to detect the emitted bremsstrahlung in coincidence with the incident electrons. Effects of about 3% were observed, in contrast to considerably larger values (13%) published in an earlier paper. The asymmetry was numerically calculated according to the method of Johnson and Rozics. Since at an electron energy of only 300 keV the Born approximation does not give good results, theory and measurement agree only in order of magnitude, particularly at high γ energies. (auth)

7529 SEARCH FOR THE RADIATIVE DECAY $Y^*(1327) \rightarrow \Lambda\gamma$. Mayeur, C. (Univ., Brussels); Van Binst, P.; Wilquet, G.; (and others). Phys. Lett: 33B: 441-4(23 Nov 1970).

A 2.1 GeV/c K^- exposure in a heavy-liquid bubble chamber was used to search for the final state $Y^*(1327) \rightarrow \Lambda\gamma$. No evidence was found for the existence of this state; an upper limit is placed on the cross section of the reaction $K^- + p \rightarrow Y^*(1327) + \pi^+ + \pi^- + n\pi^0$, $n \geq 0$. (auth)

7530 PROTON-PROTON BREMSSTRAHLUNG MEASUREMENTS AT 64.4 MeV. Galde, D. O.; Halbert, M. L.; Ludemann, C. A.; van der Woude, A. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 25: 1581-3(30 Nov 1970).

The 30-30° proton-proton bremsstrahlung cross section and its noncoplanar dependence were measured at 64.4 MeV. The measured noncoplanar dependence agrees with theoretical calculations, but the coplanar cross section, 2.32 ± 0.20 $\mu b/sr^2$, is significantly below the predicted values. (auth)

7531 FORMATION-ZONE EFFECT IN TRANSITION RADIATION DUE TO ULTRARELATIVISTIC PARTICLES. Yuan, Luke C. L. (Brookhaven National Lab., Upton, N. Y.); Wang, C. L.; Uto, H.; Pruenster, S. Phys. Rev. Lett.; 25: 1513-15(23 Nov 1970).

The formation-zone effect in transition radiation due to charged particles with large Lorentz factor γ, both in air and in aluminum, was investigated. A stack of aluminum foils spaced uniformly apart was used as the transition radiator. Positrons of 1- to 4-GeV energy (γ = 2000 to 8000 corresponding to protons of energy 2000-8000 GeV) were employed. The formation-zone effect sets in at about 5 mils in air and at around 0.5 mil in aluminum. (auth)

7532 PROTON COMPTON EFFECT. Berk, James Victor. Los Angeles; Univ. of California (1969). 98p. University Microfilms Order No. 70-14,261.

Thesis.

The differential cross sections for the proton Compton effect, $\gamma + p \rightarrow \gamma' + p'$, were measured at center-of-mass angles of 60, 75, and 90° for incident photon energies from 600 to 850 MeV. The bremsstrahlung beam was provided by the Electron Synchrotron at the California Institute of Technology. Both final state particles were detected. The incident photon energy was determined from the laboratory angle and time-of-flight of the recoil proton. The measured differential cross sections were consistent with cross sections measured in previous experiments and exhibit a smooth behavior as a function of scattering angle. (Diss. Abstr. Int., B)

7533 EXPERIMENTAL DETERMINATION OF THE SUM OF THE PROTON AND ELECTRON CHARGES. Johnston, Earl Walter. Ann Arbor, Mich.; Univ. of Michigan (1969). 90p. University Microfilms Order No. 70-14,557.

Thesis.

There recently was considerable interest in experiments which compare the magnitudes of the proton charge q_p and electron charge q_e. A determination of the comparative magnitudes from a measurement of the net charge on two macroscopic bodies of a different mass is described. The net charges on both of the bodies would not be an integral number of electron charges if the magnitudes of the proton and electron charges were not exactly equal. The charge measurements were made by suspending the bodies with a weak harmonic restoring force in a horizontal direction and measuring their displacements in an electric field applied in this direction. The bodies were suspended in their superconducting state (in which they exhibit perfect diamagnetism) in a specially shaped static magnetic field. Masses of niobium from 5 to 10 micrograms were suspended with periods of oscillation from around 1 sec to 20 sec. These small masses required the introduction of mechanical strain into them before they would exclude enough flux to be suspended. It was found that the net charges on two niobium bodies of 5 and 9 micrograms were $(0.04 \pm 0.03)e + ne$ and $(-0.03 \pm 0.08)e + n'e$ where n and n' are 0, ±1, ±2, etc. The conclusion is that $q_p + q_e = (7 \pm 8) \times 10^{-21}e$. The data of the experiment do not preclude the possibility that $|q_p + q_e| > 3 \times 10^{-19}e$ due to a coincidental cancellation of excess charge. However, other independent research suggests this is a very unlikely possibility. (Diss. Abstr. Int., B)

7534 IS QUARK THE QUARRY? Kasha, Henry (Brookhaven National Lab., Upton, N. Y.). Comments Nucl. Particle Phys.; 4: 135-9(Jul-Aug 1970).

A statistical analysis and evaluation is given for a previous search for quark tracks among particle tracks from extensive air showers. In the experiment discussed five tracks having an ionization of about half that of a relativistic particle, as established by a drop count were found among 50,000 tracks belonging to about 5000 showers. These five tracks were attributed to quarks with charge 2e/3, where e is the electron charge. Four cloud chambers triggered by an extensive air-shower array were used in this search. The possibilities of observing quarks in previous experiments are discussed relative to the experiment evaluated. (J.F.P.)

Weak

7535 (BMBW-FBK-70-16) ANGULAR DISTRIBUTION IN THE β DECAY OF Ξ^-. Siebert, H. W. (Heidelberg Univ. (West Germany). Physikalisches Institut (I)). Oct 1970. 51p. (In German). Dep. NTIS (U. S. Sales Only).

The β-decay of Ξ^- in flight was observed in a spark chamber experiment. A complete kinematic reconstruction of the observed decays was impossible due to the lack of a magnetic field for momentum determination. It is shown that an analysis of the angular distributions of the decay products yields information on the ratio g_A/g_V in two different ways. From 13 $\Xi^- - \beta$-decays an e $\bar{\nu}$-asymmetry -0.25 ± 1.0 is found for the decay $\Xi^- \rightarrow \Lambda e\bar{\nu}$. The error results from the small sample size. For the production reaction $K^-(1.65\ GeV/c) + p \rightarrow \Xi^- + K^+$ a Ξ^--polarization 0.33 ± 0.5 is found. (auth)

7536 INVESTIGATION OF THE RANGE-ENERGY RELATION IN EMULSION. Bohm, G. (Institut fuer Physik Hoher Energien, Berlin); Krecker, U.; Mayeur, C.; (and others). Nuovo Cim.: 70A: 384-90(1 Dec 1970).

An apparent variation of the mass of the Λ-hyperon with the energy of the decay π^--meson was observed in emulsion. This anomaly was attributed to a systematic error in the range-energy relation for emulsion for particle velocities greater than 0.6c. (auth)

7537 TEMPERATURE EFFECT AND HIGH-ENERGY MUON GENERATION MECHANISM IN THE ATMOSPHERE. Volkova, L. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 12: 347-59(Aug 1970). (In Russian).

It is shown that the value of the temperature effect for the 10^2 to 10^3-GeV atmospheric muons depends on the mechanism of their generation. The calculation of the temperature coefficients for such muons and the comparison with the experimentally measured coefficients help to solve the problem of the ratio of π, kaons, and mesons generated in interactions of primary cosmic rays with nuclei of the atmospheric atoms. (auth)

7538 NEUTRON PRODUCTION IN Pb AT THE DEPTH OF 150 mwe UNDER THE ACTION OF COSMIC RAY MUONS INCIDENT AT LARGE ZENITH ANGLES. Gorshkov, G. V.; Zyabkin, V. A. Yadern. Fiz.; 12: 340-6(Aug 1970). (In Russian).

Neutron production in Pb under the action of cosmic ray muons incident within the angle range $60 \leq \theta \leq 90°$ was studied by means of a cosmic ray horizontal telescope placed at the depth of 150 mwe and connected into coincidences with neutron detector. The mean energy of muons passing through the telescope was ~110 GeV. The mean value of the product of the interaction cross section and multiplicity of the neutron production calculated per one nucleon and being equal to $\overline{\sigma\nu}/A = (290 \pm 50)\ (10)^{-29}\ cm^2$/nucleon is in good agreement with the theoretical value $280.9\ (10)^{-29}\ cm^2$/nucleon calculated according to the muon electromagnetic theory. For the depth of 800 mwe the velocity of the neutron production in Pb under the action of high energy muons $(9.4\ (10)^{-9}\ g^{-1}\ sec^{-1})$ and slow negative muons $(9.2\ (10)^{-11}\ g^{-1}\ sec^{-1})$, is estimated. (auth)

7539 NEUTRINO PHYSICS. Wolfendale, A. W. (Univ. of Durham, Eng.). Essays Phys.; 2: 131-68(1970).

A brief account of the discovery and detection of neutrinos and the significance of neutrino studies in nuclear physics and astrophysics is given. Accelerator studies of neutrino interactions at Brookhaven (1962) and CERN (1964) are described. Experiments concerning elastic and inelastic neutrino interactions are considered. Sources of natural neutrinos are indicated and the energy spectra and interaction products of cosmic ray neutrinos discussed. The Kolar gold field experiment and the Case-Wits-Irvine experiment in both of which neutrino induced muons are detected are described and the observed intensities interpreted. Techniques for detecting solar neutrinos are given and the Davis experiment for neutrino detection using the chlorine capture method described. The part played by astrophysical neutrinos in theories of stellar evolution, which stems from neutrino electron interactions, is discussed. Cosmological aspects of neutrinos are also considered and the future trends in neutrino physics indicated. (UK)

Strong (Baryon-Induced)

Refer also to abstract 7683.

7540 (CONF-690608-, pp 323-38) S = 0 BARYON RESONANCES. Plano, Richard J. (Rutgers-The State Univ., New Brunswick, N. J.).

A review is given on baryon nonstrange resonances subdivided as elastic phase shift analysis; $\pi N \rightarrow N\pi\pi$ (327) production experiments (329) d^*; and $N_{\frac{5}{2}}^*$ (1659). For the N*'s, the phase shift analysis has improved the certainty of the $P_{13}(1855)$, $F_{17}(1980)$, and $D_{13}(2030)$ and given evidence for slightly different masses as well as for a somewhat larger change in the mass of the $G_{17}(2190)$. These new mass values are probably more precise than the earlier values but since they do not result from an overall fit are perhaps most useful as an indication of the uncertainties. Further evidence has been advanced for the decay of an N* near 1750 MeV into ΛK and the N*(3755) has been very much weakened. For the Δ's, the phase shift analysis has increased the probability of the $D_{35}(1950)$ and the $P_{33}(2030)$. The $\Delta(2420)$ and $\Delta(2850)$ have been clearly seen in a backward charge exchange scattering experiment, a bubble chamber observation of the $\Delta(2850)$ has disappeared and the decays of two Δ^{2+} into the $\Delta^{2+}(1236)$ have been observed. (Sweden)

7541 COMPARISON OF HIGHLY INELASTIC PROTON-PROTON AND ELECTRON-PROTON SCATTERING. Allaby, J. V.; Diddens, A. N.; Klovning, A.; Schluepmann, K.; Wetherell, A. M. (CERN, Geneva). Phys. Lett.; 33B: 429-32(23 Nov 1970).

Measurements of momentum spectra of protons inelastically scattered in proton-proton collisions at 19.2 GeV/c were carried out. A comparison is made with results from deep inelastic electron-proton scattering. (auth)

7542 OBSERVATION OF MASSIVE MUON PAIRS IN HADRON COLLISIONS. Christenson, J. H. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.); Hicks, G. S.; Lederman, L. M.; (and others). Phys. Rev. Lett.; 25: 1523-6(23 Nov 1970).

Muon pairs in the mass range $1 < m_{\mu\mu} < 6.7\ GeV/c^2$ were observed in collisions of high-energy protons with uranium nuclei. At an incident energy of 29 GeV, the cross section varies smoothly as $d\sigma/dm_{\mu\mu} \approx 10^{-32}/m_{\mu\mu}^5\ cm^2\ (GeV/c)^{-2}$ and exhibits no resonant structure. The total cross section increases by a factor of 5 as the proton energy rises from 22 to 29.5 GeV. (auth)

7543 NEUTRON SPIN-ANTINEUTRINO MOMENTUM CORRELATION IN DECAYS OF POLARARIZED NEUTRONS. Erozolimskii, B. G.; Bondarenko, L. N.; Mostovoi, Yu. A.; (and others) (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 12: 323-9 (Aug 1970). (In Russian).

The correlation B between the neutron spin and the antineutrino momentum is measured in β decay of polarized neutrons. The obtained value, $B = 0.995 \pm 0.034$, is within a standard deviation from the value 0.99, predicted by the V - A variant of the theory of weak interactions. (auth)

7544 OBSERVATION OF ^{3}He. Antipov, Yu. M.; Vishnevskii, N. K.; Gorin, Yu. P.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 12: 311-22(Aug 1970). (In Russian).

$^{\overline{3}}$He nuclei were observed in a beam of negative particles produced by 70-GeV protons on aluminium target. Among $2.4\ (10)^{11}$ particles passing through the device, five $^{\overline{3}}$He nuclei were identified by electric charge and velocity using scintillation and Cerenkov counters. The $^{\overline{3}}$He mass was found to be $M^{\Sigma}_{\overline{^3He}} = (1.00 \pm 0.03)3m_p$, the charge $Z = (0.99 \pm 0.03)2e$. The ratio of the production differential cross sections for $^{\overline{3}}$He nuclei ($p = 20\ GeV/c$) and of π mesons ($p = 10\ GeV/c$) is $2\ (10)^{-11}$ that corresponds to the cross section of $^{\overline{3}}$He production $d^2\sigma_{\overline{^3He}}/d\Omega dp = 2.0\ (10)^{-35}\ cm^2$/sterad (GeV/c) per Al nucleus and $2.2\ (10)^{-36}\ cm^2$/sterad (GeV/c) per nucleon. (auth)

7545 NEUTRON-PROTON, NEUTRON-DEUTERON, AND NEUTRON-NUCLEUS TOTAL CROSS SECTIONS AT 4.0 AND 5.7 GeV/c. Parker, Everette Francis. Ann Arbor, Mich.; Univ. of Michigan (1969). 77p. University Microfilms Order No. 70-14,612.

Thesis.

Neutron total cross sections were measured for H_2, D_2, He, Be, C, Al, Fe, Cu, Cd, W, Pb, and U at $5.7 \pm 0.6\ GeV/c$ incident momentum. The hydrogen and deuterium cross sections were also measured at $4.0 \pm 0.6\ GeV/c$. The deuteron screening factor was determined from the hydrogen and deuterium cross sections. The resulting values are compared with the previous experimental evaluations and theoretical predictions. The total cross section vs atomic weight data were fitted to an optical model. The experiment was performed at the Bevatron of the Lawrence Radiation Laboratory. (Diss. Abstr. Int., B)

7546 LARGE-ANGLE ANTIPROTON-PROTON ELASTIC SCATTERING. Falconer, David George. Ann Arbor, Mich.; Univ. of Michigan (1969). 350p. University Microfilms Order No. 70-14,511.

Thesis.

XUM

An experimental and theoretical investigation of the large-angle antiproton–proton cross section indicates that substantial local structure exists both as a function of beam momentum and four-momentum transfer, and that such structure may be attributed, respectively, to the formation of direct-channel boson resonances, and the exchange of meson and nucleon states between the target and projectile. The differential cross section measurements were made using data from the Argonne thirty-inch MURA chamber at the six beam momenta (invariant masses) 1.63, (2298), 1.77 (2350), 1.83 (2368), 1.88 (2389), 1.95 (2412), and 2.20 GeV/c (2500 MeV), and at momentum-transfers squared greater than $|t| = 0.3$ $(GeV/c)^2$. Off the forward peak the cross section is observed to drop to the familiar minimum at $|t| = 0.4$, rise to a secondary maximum at $|t| = 0.7$, and then form a plateau beginning around $|t| = 1.1$, and extending well into the backward hemisphere. At the very largest scattering angles a sharp, energy-dependent backward peak rises from the plateau backward of $\cos\theta = -0.9$. Interpreted as evidence for a direct-channel boson resonance, the enhancement appears centered at 2345 MeV with a width of 140 MeV, the values quoted previously for one of the total cross section structures. The observed cross sections were treated analytically by modifying several current theoretical models for application to antiproton–proton elastic scatterings. Starting with the Chou-Yang interaction picture it is shown that a time-independent optical potential governs the interaction between target and projectile, and that for relativistically compressed, gaussian-shaped particles the forward differential cross section depends exponentially on t. In an attempt to account for antishrinking and dip-bump structure, the difference between the P-P, and PBAR-P scattering amplitudes is attributed to an annihilation potential arising from the exchange of a nucleon between the target and projectile. The difference amplitude is then calculated using the Feynman one-particle-exchange mechanism, with absorption corrections deduced from the eikonal picture of R. Glauber. The dip-bump sequence following the forward diffraction peak is credited to interference between the high-energy, and difference amplitudes. The above processes were also treated with Regge-cut theory. In this context the forward peak is attributed to the artifice of Pomeranchon exchange, its antishrinking to the exchange of a nucleon-isobar trajectory, and the dip-bump sequence to interference between the Pomeranchon and difference amplitudes. The predicted cross section—obtained again via the eikonal picture—is then compared with that produced by reggeizing the multiperipheral contributions from isobar exchange along the lines suggested previously, and conclusions drawn that the two processes are not readily distinguished. (Diss. Abstr. Int., B)

7547 MAGNETIC MOMENT OF THE Σ^+ HYPERON. Benbrook, James R. Seattle; Univ. of Washington (1969). 286p. University Microfilms Order No. 70-14,734.

Thesis.

The magnetic moment of the Σ^+ hyperon was measured in this experiment. A total of 1777 Σ^+ hyperons were produced in the reaction $\pi^+ + p \rightarrow K^+ + \Sigma^+$ at a π^+ momentum of 1280 MeV/c. The K^+ and the Σ^+ and its decay proton were observed in a small optical spark chamber located inside the bore of a solenoidal pulsed magnet. The measurement of the precession of the asymmetric decay distribution from the polarized 955 field "on" Σ^+ events yields a number $\mu_{\Sigma^+} = 2.68 \pm .97$ nuclear magnetons. The average polarization of the whole sample of 1777 events is $\alpha\bar{P} = -.558 \pm .039$. (Diss. Abstr. Int., B)

7548 PION AND PROTON PRODUCTION IN PROTON–PROTON COLLISIONS AT 12.4 GeV/c. Day, John Layton. Ann Arbor, Mich.; Univ. of Michigan (1969). 78p. University Microfilms Order No. 70-14,497.

Thesis.

The differential production cross section for pions and the differential inelastic cross section for protons were studied in proton proton collisions at 12.4 GeV/c. The cross sections for the pions were measured on lines of fixed $P_\parallel$ and $P_\perp^2$ in the center of mass while circles of fixed energy loss in the center of mass were used for the protons. There are two main features of the pion data. When the cross section $d^2\sigma/d\Omega dp$ for the pion is plotted against $P_\perp^2$, there is a maximum at $P_\perp^{cm} = 0$ GeV/c which contradicts earlier evidence of a two-center model of particle production. It is now believed that this earlier evidence is in error. The second point is that a very sharp forward peak of the form $e^{-18P_\perp^2}$ appears in the $P_\perp$ dependence. A plot of the proton data shows the cross section to be a gaussian which is independent of the value of the circles of fixed energy loss. This was a totally counter experiment consisting of a liquid hydrogen target, three magnets, scintillation counters, and one gas threshold Čerenkov counter. The second extracted proton beam (EPB II) of the ZGS was the source of impinging protons. (Diss. Abstr. Int., B)

7549 HIGH-ENERGY COSMIC-RAY INTERACTIONS IN EMULSION CHAMBERS. Gibbs, Robert Edward. Seattle; Univ. of Washington (1969). 161p. University Microfilms Order No. 70-14,756.

Thesis.

A horizontal-plate emulsion chamber using alternate layers of plastic and emulsion was designed and exposed to the primary cosmic radiation in high altitude balloon flights. The disintegration of cosmic ray heavy nuclei in the chamber provides a nearly monoenergetic "beam" of high-energy nucleons. The subsequent interactions of these nucleons were studied. The average multiplicity for proton collisions in hydrocarbons is determined to be: $\langle n_s \rangle = 17.2 \pm 2.1$ at $E_p = 2.0$ TeV and $\langle n_s \rangle = 17.2 \pm 2.3$ at $E_p = 7.8$ TeV. The angular distribution of created secondary particles is found to be less anisotropic than the "thermodynamical model" predictions. The average transverse momentum of protons and alpha particles from the primary "break-up" is found to be: $\langle p_{t_p} \rangle = 0.46$ GeV/c; $\langle p_{t_\alpha} \rangle = 0.23$ GeV/c. These are higher values than have been found at lower energies. (Diss. Abstr. Int., B)

Strong (Meson-Induced)

7550 (CONF-690608–, pp 237-68) REVIEW OF STRONG INTERACTIONS OF KAONS. Morrison, D. R. O. (European Organization for Nuclear Research, Geneva (Switzerland)).

The review of the strong interactions of K-mesons is divided into the following subjects: total cross sections; elastic scattering; inelastic two-body reactions; many-body reactions; production of "rare" particles; summary and future; Results from the Serpukhov accelerator show that the total K^-p cross section is almost constant. In elastic scattering, a second maximum occurs in π^+p, π^-p, $\bar{p}p$ and K^-p reactions, but does not occur in pp, pn or K^+p scattering: A number of theories offer explanations of these results. In K^-p elastic scattering, dips are observed near $t = -0.85$ GeV^2 and $u = -0.3$ GeV^2. In the reaction $K^-n \rightarrow \pi^-\Lambda$, the polarization observed is in serious disagreement with an extrapolated Regge pole prediction. It is a remarkable coincidence that the total elastic cross sections for K^+p and K^-p are so similar, when the two reactions are so different in all other respects. In the reaction $K^+p \rightarrow pK^+\pi^0$, the percentage of quasi two-body reactions is approximately energy independent. (Sweden)

7551 (CONF-690608–, pp 271-320) MESON RESONANCES. Maglic, Bogdan (Rutgers–The State Univ., New Brunswick, N. J.).

A review is given on meson resonances where the subject is subdivided as; mass >1900 MeV and "direct channel" resonances; empirical regularity; cascade decays; narrowing at high mass; production at high $/t/$; π-π s-wave resonance; fine structure; quark model; splitting of the A2-meson; splitting in general; decays; R-region; strange mesons; and tachyons. (Sweden)

7552 (COO-1195-201) FAILURE OF S-CHANNEL HELICITY CONSERVATION IN A_1 PRODUCTION. Ioffredo, M. L.; Ascoli, G.; Brockway, D. V.; Eisenstein, L.; Kruse, U. E.; Schultz, P. (Illinois Univ., Urbana). Oct 1970. Contract AT(11-1)-1195. 7p. (CONF-701108–2). Dep. NTIS.

From Meeting of the Division of Particles and Fields of the American Physical Society, Austin, Tex.

The polarization of the A_1 as produced in $\pi^-p \rightarrow p\pi^-\pi^+\pi^-$ interactions is studied between 5 and 20 GeV/c. It is found that s-channel helicity is not conserved. Instead the density matrix elements have simple behavior with ρ_{00} near 1 for the Gottfried–Jackson frame. A new analysis of the A_1 cross section as a function of incident momentum is also shown. (auth)

7553 (JINR-P1-5059) SEARCH FOR ISOBAR WITH ISOTOPIC SPIN $T = 5/2$ IN THE REACTION $\pi^+ + p \rightarrow \pi^- + X^{3+}$. Birulev, V. K.; Vovenko, A. S.; Guskov, B. N.; (and others). (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 11p. (In Russian). Dep. NTIS (U.S. Sales Only).

The spectrum of negative pions was measured in the reaction $\pi^+ + p \rightarrow \pi^- + X^{3+}$ at the π^+ meson momentum of 3.88 GeV/c and the π^- meson emission angle of 1.9° (l.c.s.). In the obtained spectrum the maximum was observed which can be explained by kinetic effect of the coproduction of Δ^{2+} (1.24) isobar and ρ^0 meson. Within the experimental errors the production of the isobar with the isotopic spin $T = 5/2$ in the mass range from 1.2 to 2.2 GeV/c^2 was not observed. Statistically unjustified deflection from the smooth theoretical curve in the mass region of 1.5 to 1.7 GeV/c^2 can be observed. (auth)

7554 (UCRL–19790) $K^-p \rightarrow \Sigma^+ + \pi^-$ BETWEEN 1730 MeV AND 2150 MeV. Kane, D.; Birge, R. W.; Ely, R. P. Jr.; Hoven, J.; Kalmus, G. E.; Van Horn, A. (California Univ., Berkeley.

Lawrence Radiation Lab.). Aug 1970. Contract W-7405-eng-48. 15p. (CONF-700806-51). Dep. NTIS.

From 15th International Conference on High Energy Physics, Kiev, USSR.

A bubble chamber study was made of the two-body channels $\Sigma^+\pi^-$ and $\Sigma^-\pi^+$ produced by scattering a K^- beam on protons at 1730 to 2150 MeV. Cross sections, angular distributions, and polarizations were obtained from the data. A conventional partial-wave analysis of the data was made, and energy-dependent best fits are summarized. (L.B.S.)

7555 EVIDENCE FOR THE EXISTENCE OF PARTICLE-UNSTABLE STATES OF THE $^{12}_{\Lambda}C$ AND $^{14}_{\Lambda}N$ HYPERNUCLEI. Bohm, G. (Deutsche Akademie der Wissenschaften, Berlin); Klabuhn, J.; Krecker, U.; (and others). Nucl. Phys.; B24: 248-52(1970).

Evidence is presented for the existence of particle-unstable states of the $^{12}_{\Lambda}C$ and $^{14}_{\Lambda}N$ hypernuclei produced by the absorption at rest of K^- mesons in light emulsion nuclei. (auth)

7556 STUDY OF THE DI-PION IN THE MASS-VALUE REGION $M(\pi^0\pi^0) \leq 1.3$ GeV. Strugalski, Z. S.; Chuvilo, I. V.; Fenyves, E.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; B24: 358-64(1970).

The results of investigation of the $\pi^0\pi^0$ effective-mass spectrum in the mass-value region $M(\pi^0\pi^0) \leq 1.3$ GeV are presented. A peak is observed at $M(\pi^0\pi^0) \approx 730$ MeV. (auth)

7557 REACTIONS $K^-p \rightarrow \Sigma^{+-}\pi^{-+}$ IN THE C.M. ENERGY RANGE 1915 TO 2168 MeV. Berthon, A. (College de France, Paris); Vrana, J.; Butterworth, I.; (and others). Nucl. Phys.; B24: 417-40(1970).

A formation study of the reactions $K^-p \rightarrow \Sigma^{\pm}\pi^{\mp}$ at 13 incident momenta between 1.26 and 1.85 GeV/c is reported. Total and differential cross sections together with the Σ^+ polarization are given. A partial-wave analysis is performed yielding relevant information on the $\Sigma(1915)$, $\Sigma(2030)$ and $\Lambda(2100)$ resonances. The implications for the SU(3) classification of these states are discussed. The possible existence of other resonances is investigated. (auth)

7558 OBSERVATION OF $K_L - K_S$ REGENERATION FROM LIQUID HYDROGEN. Darriulat, P. (CERN, Geneva); Grosso, C.; Holder, M.; (and others). Phys. Lett.; 33B: 433-7(23 Nov 1970).

The $K_L - K_S$ transmission regeneration of a K_L beam traversing a liquid hydrogen target has been observed over the momentum interval 3.0-6.0 GeV/c. Results are in good agreement with predictions based on dispersion relations. (auth)

7559 INTERACTIONS OF 16.2-GeV NEGATIVE PIONS WITH EMULSION NUCLEI. O'Reilly, Patrick Daniel. Norman, Okla.; Univ. of Oklahoma (1970). 195p. University Microfilms Order No. 70-14,423.

Thesis.

A stack of Ilford K-5 nuclear emulsion was exposed to a 16.2-GeV negative-pion beam at CERN. A group of 298 pion-nucleus interactions was randomly selected for analysis from the events which were found in scanning the processed plates. The mean free path for the interaction of a pion with an average emulsion nucleus was determined. Calculations were made to determine the screening effect of the surrounding nucleons on the interaction cross section. Out of a total of 1609 secondary pions, the momenta of 736 were measured using multiple Coulomb scattering techniques. The angle of emission of all the secondary pions was measured. Using standard selection criteria, the events were divided according to the size of the target nucleus involved in the interaction. The angular distributions, transverse momentum distributions, average transverse momenta, and inelasticity for pion production were determined. The results were compared with various theoretical models and previous experimental results of high-energy particle-nucleus interactions. The results of this experiment were generally found to be in agreement with previous results. The observed results appeared to be more in agreement with the cascade model of particle-nucleus interactions than with the tube model. A comparison of these results was made with those obtained from an analysis of 16.2-GeV pion-nucleon interactions. Comparisons were also made with other pion-nucleon experimental results. Similarities were noted in the behavior of the transverse momenta in the two types of interactions. In order to obtain a good fit with a theoretical distribution function to the p_T data obtained in this experiment, it was necessary to establish a cut-off in the p_T values and to consider errors in the observed frequencies in each p_T interval. In this way, the linear exponential distribution yielded the best fit to the p_T data. No indications of multi-pion resonance formation were observed in the invariant mass spectra. (Diss. Abstr. Int., B)

7560 EMULSION STUDY OF PION-NUCLEON INTERACTIONS AT 16.2 GeV. Samimi, Jalal. Norman, Okla.; Univ. of Oklahoma (1970). 192p. University Microfilms Order No. 70-14,430.

Thesis.

Ilford K-5 nuclear emulsion was exposed to a 16.2-GeV negative pion beam. A total of 509 pion-nucleon interactions were located by scanning along the track of 1.8 kilometer of the pion beam track. Experimental criteria for the collision of a pion with a single nucleon were developed, and all the interactions were tested to satisfy these criteria. Kinematical quantities of most of the secondary particles from these interactions were measured. A new formalism was developed in multiple Coulomb scattering measurement techniques in determining momenta of the high energy pion tracks. The cross sections for different pion-nucleon processes are measured. The pion multiplicity distributions are obtained and compared to theoretical curves. The secondary pion transverse momentum distributions are fitted with different distribution functions. The dependence of the average transverse momentum on angle and multiplicity is obtained. For the angular interval 0-5°, $\langle p_t \rangle$ is found to decrease with increasing n_s. Dependence of $\langle p_t \rangle$ on the center of mass angle of emission shows a peak at and a symmetry about 90°. The center of mass angular distributions of secondary pions shows an extreme forward peak for small n_s and becomes almost isotropic for large n_s. The concept of effective target mass is found to be unrelated to any physical mass. However, it is found to increase with n_s. The interactions are observed to proceed via resonances. In addition to the known resonances, a peak at 3100 MeV is observed which may be interpreted as a charged state of the known resonance N(3030), or a new resonance. (Diss. Abstr. Int., B)

7561 RESONANCE PRODUCTION IN π^-p INTERACTIONS AT 7.0 GeV/c. Morse, Robert Malcolm. Madison, Wis.; Univ. of Wisconsin (1969). 270p. University Microfilms Order No. 70-3639.

Thesis.

The MURA 30'' hydrogen bubble chamber at the ZGS was used to study inelastic π^-p interactions at 7.0 GeV/c. Two tantalum plates mounted in the chamber allowed reconstruction of 3,100 $\pi^-p \rightarrow \pi^-\pi^0\pi^0p$ events from a sample of 5,600 $\pi^-p \rightarrow \pi^-p\, k\gamma$'s, $k = 1,2,\ldots$. In addition 6,000 $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ events were reconstructed from the approximately 300,000 pictures in this exposure. These inelastic processes were found to be dominated by ρ-production, and multipion resonance production, A_1, A_2 and A(1230) as well as numerous nuclear isobars. All the effective mass distributions obtainable from the $\pi^-\pi^0\pi^0p$ and $\pi^-\pi^-\pi^+p$ final states as well as the cross sections for resonant production in these final states are presented. Particular emphasis is given to $I = 2\pi\pi$ elastic and inelastic scattering up to 2.0 GeV using Benecke-Dürr corrections to the OPE formalism. These techniques yield $I = 2\pi\pi$ cross sections, phase shifts, and inelasticities. It is found that d-waves become important at about 0.8 GeV, and g-waves at about 1.4 GeV. The scattering also becomes inelastic at about 1.2 GeV, and appears predominately diffractive above 1.6 GeV. The scattering amplitude is still relatively real ruling out a pure Pomeranchuk exchange. Finally, a careful study of the low mass $p\pi\pi$ regions is made. Both regions are characterized by large cross sections at threshold and are produced by extremely peripheral mechanisms, indicating that diffraction dissociation processes $\pi \rightarrow \rho\pi$, and $p \rightarrow \Delta^{++}\pi^-$ may dominate. Superimposed on the large "Deck" type $\rho\pi$ predominately $J_P = 1^+$, 2^- background is the $A_1(1^+)$, the $A_2(2^+)$, and evidence for an A(1230, $2^-(1^+)$) state. The $p\pi\pi$ diffractive background is found to be predominately $\Delta^{++}\pi^-$ in a $J_P = 3/2^-$ state, and evidence for the N^*-(1490), $N^*(1680)$, and $N^*(1710)$ is seen superimposed on this background. Cross sections, decay modes and J_P determinations of the resonances and background in these two regions are determined. (Diss. Abstr. Int., B)

7562 INVESTIGATION OF CORRELATIONS BETWEEN LONGITUDINAL AND TRANSVERSE MOMENTUM COMPONENTS FOR SECONDARY PARTICLES IN VARIOUS FINAL STATES OF π^-p COLLISIONS AT 4.0 GeV/c WITH PRODUCTION OF STRANGE PARTICLES. Kuznetsov, A. A.; Mel'nikova, N. N.; Chadraa, B.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 12: 334-9(Aug 1970). (In Russian).

Results are presented on correlations between longitudinal and transverse momentum components for secondary particles produced in various chanels of the π-p reaction at 4.0 GeV/c with production of strange particles. The correlations are shown to exist for pions, kaons, and baryons and may be reasonably described by the phase volume for pions only, when they are produced in reactions with large number of secondary particles. A new parameter suitable for analysis of the interactions is introduced. (auth)

XUM

Particle Interactions and Properties (Theoretical)

General

7563 (CONF-690608) PROCEEDINGS OF THE LUND INTERNATIONAL CONFERENCE ON ELEMENTARY PARTICLES HELD AT LUND, SWEDEN, JUNE 25–JULY 1, 1969. von Dardel, G. (ed.) (Lund Univ. (Sweden). Inst. of Physics). 452p.

The conference included 16 papers, two of which were abstracted previously in NSA. For abstracts of these papers see 23: 51876 and 24: 20141. Separate abstracts were prepared for 14 papers. (J.F.P.)

For abstracts of individual papers see: 7540, 7550, 7551, 7564, 7565, 7609, 7621, 7622, 7636, 7637, 7653, 7654, 7679, and 7767.

7564 (CONF-690608–, pp 225-33) CURRENT ALGEBRA. Renner, B. (Cambridge Univ. (England)).

A review of current algebra from the aspects of experimental status; chiral symmetry; anomalies of axial current; duality; electromagnetic and weak interactions; representations at infinite momentum; dilatations and conformal transformations are given. Four approaches of current algebra have emerged; currents as basic observables proposed to satisfy simple communication relations suggested by Dirac, Heisenberg, and Gell–Mann. This approach is the only one which unambiguously specifies the scale of the weak current, by demanding that the hadron weak currents have the same algebraic properties as the lepton weak currents, namely an SU_2 algebra. Current algebra as a property of the quark model: the currents are given in terms of simple quark bilinears. The quark model continues to be successful in explaining the gross features of the hadron spectrum; it is remarkably well adaptable to the concepts of duality, as the new technique of duality diagrams has shown once again. An approach to current algebra from chiral symmetry has been strongly argued for by Weinberg at the Vienna conference. Finally, close relations between chiral symmetry and duality predictions, in particular those of the Veneziano model, have been suggested by Lovelace. Since this is the main new ingredient, a considerable part of the review is devoted to discussion of the implications of this approach. (Sweden)

7565 (CONF-690608–, pp 411-15) COMPILATION OF COUPLING CONSTANTS AND LOW-ENERGY PARAMETERS (SELECTED FROM RECENT PUBLICATIONS, JUNE 1969). Ebel, G.; Pilkuhn, H.; Steiner, F. (Karlsruhe Univ. (West Germany)).

The compilation of coupling constants and low-energy parameters covers πN scattering, $K^{\pm}N$, $\pi\Sigma$, and $\pi\Lambda$ channels, NN scattering, photon couplings, pion photoproduction, and weak interactions. (J.F.P.)

7566 (JINR–P2-5063) PROBLEM OF ELEMENTARY PARTICLE IDENTITY. Lyuboshits, V. L.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

A problem of continuous transition between the properties of systems of identical and nonidentical particles was considered. It is shown that in the presence of degeneration on some inner quantum number the degree of nonorthogonality of corresponding superpositions is a continuous parameter of such a transition. A logically possible scheme is described in the framework of which the identity of particles is approximate. (auth)

7567 (JINR–P2-5272) RELATIVISTIC S = 1/2 SPIN ROTATION IN COLLISIONS OF PARTICLES MOVING ARBITRARY RELATIVE TO THE OBSERVER. Golovin, B. M.; Nikanorov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

A relativistic rotation of S = 1/2 spin of particles, taking part in a binary reaction at an arbitrary motion of colliding particles, are considered using the Lobachevsky geometry. It is shown that in the general case the relativistic spin rotation is necessary to be taken into account not only in a final, but also in an initial state of a system. (auth)

7568 (NP–18542) SPIN AND UNITARY SPIN IN THE VENEZIANO MODEL I. Montvay, I. (Roland Eotvos Univ., Budapest (Hungary). Inst. for Theoretical Physics). Apr 1970. 20p. (ITP–277). Dep. NTIS (U. S. Sales Only).

A general method is described by which it is possible to introduce in the generalized Veneziano model positive intercept/boson and fermion/leading trajectories without parity doubling and ghosts. The amplitudes with two and four external fermions are considered. The main hypothesis is factorization. (auth)

7569 (NP–18579) POSSIBLE TESTS OF THE VALIDITY OF CURRENT ALGEBRA OR FIELD ALGEBRA COMMUTATORS. Note No. 280. Bietti, A. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 29 Jul 1970. 11p. Dep. NTIS (U. S. Sales Only).

Some sum rules derived from commutators of current and field algebra are re-examined, and it is determined whether a reasonable saturation of them can give indications in order to choose between the commutators. Restriction is made to the Dashen–Lee magnetic moment sum rule and a sum rule derived directly from a given commutator. It is concluded that although definite evidence towards current algebra or the algebra of fields is not shown, nevertheless, some indication that favors the quark model is found. (J.F.P.)

7570 (RLO–1388-589) SUMMING SOFT PIONS. Brown, Lowell S. (Washington Univ., Seattle. Dept. of Physics). [1970]. Contract AT(45-1)-1388. 11p. Dep. NTIS.

A simple derivation of Weinberg's result on the chiral–symmetric coupling of soft pions to a high-energy process is presented. The formula for soft virtual pion corrections is shown to be not invariant under canonical transformation of the pion field. Thus, this formula is model-dependent and not a consequence of chiral symmetry. (auth)

7571 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 23, 1970. Frankfurt am Main; Zentralstelle fuer Atomkern-energie-Dokumentation (1970). 75p.

7572 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 22, 1970. Frankfurt am Main; Zentralstelle fuer Atomkern-energie-Dokumentation (1970). 68p.

7573 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 21, 1970. Frankfurt am Main; Zentralstelle fuer Atomkern-energie-Dokumentation (1970). 66p.

7574 EXPANSION OF AN n-POINT FUNCTION AS A SUM OF COMMUTATORS. Zagier, Don B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. J. Math. Phys. (N. Y.); 11: 3253-7(Nov 1970).

We write the n-point function of currents as a sum over nested commutators, a form more suitable for certain current algebra calculations. (auth)

7575 COVARIANT TIME-ORDERED PRODUCTS OF N NON-CONSERVED CURRENTS. Yang, T. C. (Univ. of Rochester, N. Y.). Phys. Rev., D; 2: 2312-25(15 Nov 1970).

The covariant time-ordered products of arbitrary numbers of nonconserved currents are shown to exist. The rules for constructing such products are formulated and show explicitly that they are covariant under Lorentz transformations. (auth)

7576 CONSISTENCY CONDITION FOR PROPAGATORS. Iwasaki, Yoichi (Kyoto Univ.). Phys. Rev., D; 2: 2255-6(15 Nov 1970).

It is shown that there is a strict condition for the propagators of higher-spin particles. The consistency of the propagator is required when a particle propagates by means of self-energy-type interactions. A kind of unitarity is required. Then this requirement turns out to be a strict condition in the case of higher-spin particles. Its nontriviality is due to the fact that free fields of higher-spin particles contain redundant components, which are suppressed by means of subsidiary conditions, not satisfied by the currents coupled with the fields. The usual propagators do not satisfy our requirements, while those which have been introduced in connection with the O(4) symmetry satisfy it. Also, a difficulty of the scalar-tensor theory of the graviton is pointed out. (auth)

7577 STRUCTURE OF AN EQUAL-TIME COMMUTATOR OCCURRING IN A THEORY OF CURRENTS. Ahmed, M. A. (International Centre for Theoretical Physics, Trieste, Italy); Fairlie, D. B. Phys. Rev., D; 2: 2362-4(15 Nov 1970).

The structure of an equal-time commutator involving the time component of the axial-vector current and its divergence is investigated. It is shown that the value of the equal-time commutator, formerly given by a power-series expansion, can be obtained in a closed form. (auth)

7578 BREAKDOWN OF THE POMERANCHUK THEOREM AND THE BEHAVIOR OF THE LEADING J-PLANE SINGULARITY. Arafune, Jiro; Sugawara, Hirotaka (Tokyo Univ.). Phys. Rev. Lett.; 25: 1516-18(23 Nov 1970).

It is proven that the leading J-plane singularity in the symmetric partial-wave amplitude $F_J^+(t)$ near t = 0 should behave like $\alpha_\xi(t) = 1 \pm At^{\frac{1}{2}}$ + terms of higher order in t; namely, the Pomeranchuk pole (or cut) must be a pair of complex-conjugate poles (cuts) if the total cross sections $\sigma_T^{\bar{p}p,a}(s) \xrightarrow{s\to\infty}$ const and $\sigma_T^{\bar{p}p}(\infty) \neq \sigma_T^{ap}(\infty)$, where p and a denote particle-particle and antiparticle-particle scattering, respectively. Only unitarity and analyticity are used to prove this. (auth)

7579 SCALING TRANSFORMATIONS AND CURRENT ALGEBRA. Genz, H. (Univ., Karlsruhe, Ger.); Katz, J. Lett. Nuovo Cim.; 4: 1103-5(5 Dec 1970).

It is shown that in a scale-invariant theory the assumption that the dilatation charge annihilates the vacuum is in formal contradiction with definite scaling properties of the currents, charge algebra, and the existence of the equal-time current commutators. (J.F.P.)

7580 DISCUSSION ON DUALITY: REGGEONS AND RESONANCES IN ELEMENTARY PARTICLE PROCESSES. Proceedings of the Royal Society, London, September 8, 1970. Proc. Roy. Soc. (London), Ser. A; 318: 245-399(8 Sep 1970). (CONF-700916).

Eight papers were presented at the discussion. A separate abstract was prepared for each paper. (UK)

For abstracts of individual papers see: 7581, 7631–7634, 7649, 7671, and 7762.

7581 GENERALIZED VENEZIANO MODEL. Chan, Hong-mo (CERN, Geneva). Proc. Roy. Soc. (London), Ser. A; 318: 379-99(8 Sep 1970).

From Proceedings of the Royal Society, London, England. See CONF-700916.

The generalization of the Veneziano model to many-particle reactions is reviewed with a special emphasis on the earlier literature. The latest developments are also briefly indicated. (auth) (UK)

7582 PION AMPLITUDES IN A NONCHIRAL WORLD. Brandt, Richard A.; Preparata, Giuliano (Rockefeller Univ., New York). Ann. Phys. (N. Y.); 61: 119-81(Nov 1970).

The popular strong PCAC(i.e., pion pole dominance of all Green's functions involving the divergence D of the axial vector current) and good chiral SU(2) × SU(2) symmetry framework has led to many successful predictions. It also, however, leads to some difficulties since, for example, it predicts the approximate vanishing of the K_{l3} form factor ratio $\xi = f_-/f_+$, of the $\pi^0 \to \gamma\gamma$ decay amplitude F_π (except in models with anomalous PCAC), and of the $\eta \to 3\pi$ decay amplitude A_η. Therefore an alternate framework is proposed based on weak PCAC(i.e., pion pole dominance of physical matrix elements of D) and good SU(3). It is shown that a precise formulation of these older ideas can reproduce all of the good results of the chiral scheme and none of the bad ones. The usual Gell–Mann current algebra and the $(3, \bar{3}) + (\bar{3}, 3)$ symmetry breaking Hamiltonian $H' = \alpha_0 S^0 + \alpha_8 S^8$ are assumed. There is made and motivated with reference to a composite picture of the hadrons, the following four assumptions: (1) approximate SU(3), (2) weak PCAC, (3) minimal subtractions, (4) Regge theory. In this framework, the dominance of a given Green's function T by the pion pole depends on the nature of the dispersion relations it satisfies in variables for which the absorptive part is expressible in terms of physical matrix elements of D. An unsubtracted dispersion relation leads to pole dominance but a subtracted one introduces a constant (or worse) difference between T and the corresponding on-shell pion amplitude. From assumptions (2)–(4), the following successful results of the chiral framework are derived: the Adler consistency condition, the Adler–Weisberger relation, the Weinberg–Tomozawa pion-target scattering lengths, the Weinberg π-π scattering lengths, the Fubini one-pion production relations, the Weinberg–Callan–Treiman K_{l4} form factors, and the $K_{3\pi}$–$K_{2\pi}$ relations. The extra parameters (subtraction constants) encountered in applying weak PCAC, as determined by Regge theory, turn out not to contribute to these relations. Adding assumption (1), the further results: $(\alpha_0/\sqrt{2}\alpha_8) \simeq -0.17$, $\xi \simeq -1$, and an excellent simultaneous fit to the S-wave and P-wave hyperon decays are obtained. Here the extra parameters turn out to be present precisely in the places where they are required to insure the consistency of the approach. (For example, the σ terms in the scheme need not be small.) None of these results are common to the chiral framework. It is shown further that F_π and A_η need not approximately vanish in the framework. It is therefore concluded that the theory seems to provide a better description of the present empirical situation than does the chiral theory. (auth)

Electromagnetic

Refer also to abstract 7541.

7583 (BMBW-FBK-70-21) RELATION BETWEEN FORM FACTORS AND BOOTSTRAP HYPOTHESIS. Rosenthal, P. (Marburg Univ. (West Germany). Institut fuer Theoretische Physik). Oct 1970. 34p. (In German). Dep. NTIS (U. S. Sales Only).

Qualitative relations between electromagnetic form factors following from a simple pion bootstrap are briefly recapitulated (comp. P. Rosenthal, Forschungs-Ber. BMwF, 1968) in order to emphasize certain general aspects of the problem. Analytical properties of the "bootstrap"-form factor are discussed subsequently. (auth)

7584 (DNPL/R-8) LOW-ENERGY PION PHOTO- AND ELECTROPRODUCTION ON NUCLEONS BY CURRENT ALGEBRA. Daresbury Lecture Note Series No. 3. Notes based on lectures given at Daresbury Nuclear Physics Laboratory, July 1970. Verzegnassi, C. (Daresbury Nuclear Physics Lab. (England)). 1970. 104p. Dep. NTIS (U. S. Sales Only).

Nucleon production is discussed under the following headings; photo- and electroproduction kinematics, soft pion theorems for photo- and electroproduction, electroproduction for equal time commutators, the explicit derivation of the amplitudes at threshold, the explicit form of the multipoles and its comparison with the experimental data. It is shown that charged pion photo- and electroproduction at $\theta = 90°$ in the low energy region can be completely described by knowing only the threshold amplitudes, which may be obtained by saturating sum rules derived by current algebra commutators. It is concluded from the computations involved that soft pion approximations cannot be used for multipoles. (UK)

7585 (EFI-TF-6-69) ON THE PHOTOPRODUCTION OF ρ^+-MESON BY POLARIZED γ-QUANTA IN ρ-MESON EXCHANGE PERIPHERAL MODEL. Shakhbazyan, V. A.; Shakhbazyan, K. M. (Akademiya Nauk Armyanskoi SSR, Erevan. Institut Fiziki). 1969. 17p. (In Russian). Dep. NTIS (U.S. Sales Only).

The gauge-invariant generalization of the ρ-meson exchange pole model is carried out for processes in the spirit of previous work. The differential cross section for the processes in the case of polarized γ quanta is calculated. It is shown, that in a pole approximation, when γ quantum polarization is perpendicular to the plane of reaction, the expressions depend only on one unknown parameter, the g factor of the ρ meson and make possible the selection of its sign. (auth)

7586 (IC-70/34) LECTURES ON BOUND ELECTRON PROBLEMS (CHAPTERS I-III). Fronsdal, C. (International Centre for Theoretical Physics, Trieste (Italy)). May–Oct 1970. 44p. Dep. NTIS (U. S. Sales Only).

The discussion of bound electron problems covers the Schroedinger theory in lagrangian form, solutions of the unperturbed problem, transition probability, cross sections, radiation theory, first-order electromagnetic transition, Compton scattering, and Bargmann and Fock treatment of O(4) symmetry. Various topics in group theory are also considered. (J.F.P.)

7587 (ORNL-4631) ENERGY DEPOSITION BY 45-GeV PHOTONS IN Be AND Al. Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Nov 1970. Contract W-7405-eng-26. 7p. Dep. NTIS.

Electron–photon cascade calculations have been carried out for zero-width beams of 45-GeV photons normally incident on semi-infinite slabs of beryllium and aluminum, and the energy deposition is given as a function of both depth and radius in the slabs. (auth)

7588 HIGH-MOMENTUM TRANSFER BEHAVIOUR OF NUCLEON FORM FACTORS FROM CHIRAL INVARIANT LAGRANGIANS. Martin, T. P.; Taylor, J. G. (Univ. of Southampton, Eng.). Nucl. Phys.; B24: 365-97(1970).

The behavior of the isovector and isoscalar form factors $F_1(q^2)$ and $F_2(q^2)$ for large q^2 was evaluated using a chiral invariant Lagrangian to second and third order in perturbation theory. The results depend upon the specific model chosen in this lower-order approximation, but when the effects of higher-order terms are included, the results are in agreement with the usual dipole fit to the electric and magnetic form factors. (auth)

7589 CLUSTER-EXPANSION PROCEDURES FOR THE CORRELATED CHARGE FORM FACTOR. Clark, J. W.; Ristig, M. L. (Washington Univ., St. Louis). Nuovo Cim.; 70A: 313-22(1 Dec 1970).

A factor-cluster or Van Kampen-type expansion is proposed for the evaluation of expectation values with respect to Jastrow wave functions, with special attention to the correlated form factor for elastic electron scattering from light nuclei. The advantages of this expansion over other means (familiar Iwamoto-Yamada-type

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expansion, single- or multiple-pair approximation) for evaluating the Jastrow form factor are displayed. (auth)

7590 GROUP-THEORETICAL ANALYSIS OF ELEMENTARY PARTICLES IN AN EXTERNAL ELECTROMAGNETIC FIELD. II. THE NONRELATIVISTIC PARTICLE IN A CONSTANT AND UNIFORM FIELD. Bacry, H. (Univ., Marseille); Combe, Ph.; Richard, J. L. Nuovo Cim.; 70A: 289-312(1 Dec 1970).

Two subgroups of the Galilei group are shown to play a particular role in the case of charged systems in an external electromagnetic field which is constant and uniform. Projective representations of these subgroups involve the electric charge and mass as generators of phase factors. Additivity and superselection rules for charge and mass appear as direct consequences. A comparison is made with the relativistic case. (auth)

7591 RELATIVISTIC CENTER-OF-MASS MOTION AND THE ELECTROMAGNETIC INTERACTION OF SYSTEMS OF CHARGED PARTICLES. Close, Francis E. (Oxford Univ.); Osborn, Hugh. Phys. Rev., D; 2: 2127-40(15 Nov 1970).

Effects arising from relativistic corrections to the c.m. motion for particles interacting with an external electromagnetic field and also for their interparticle interaction are considered. The Hamiltonian describing the electromagnetic interaction to order v^2/c^2, including Coulomb, magnetic, and spin-orbit effects, between two slowly moving charged particles is derived and the correct choice of c.m. dynamical variables is shown to be different from the usual nonrelativistic form. With the modified treatment of the c.m. motion introduced by considerations of relativistic invariance, the Hamiltonian is put in a form which exhibits, except for one term, a clean separation of over-all c.m. motion and internal dynamics and, but for this term, is of the required relativistic form to order v^2/c^2. The extra term, which spoils the above results, is demonstrated to be removed by correct treatment of the Thomas precession of the internal orbital angular momentum. Alternatively, the desired c.m. separation can be achieved by a modification of the free c.m. relativistic variables induced by the interaction. The relativistic variables for an N-body system with arbitrary interaction are briefly considered. (auth)

7592 HIGH-ENERGY BEHAVIOR NEAR THRESHOLD: MASSIVE QUANTUM ELECTRODYNAMICS. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Contract AT(30-1)-4101. Phys. Rev., D; 2: 2276-84(15 Nov 1970).

All scattering amplitudes in quantum electrodynamics in the limit $s \to \infty$, with t near or at the two-photon threshold are studied. In this limit, the power of s for a diffractive amplitude with a two-photon cut is found to be promoted from 1 to $\frac{3}{2}$. The fourth-order electron-electron scattering amplitude is first studied by the method of Feynman parameters. The method of impact diagrams is next generalized to handle the more complicated cases. The new method is then applied explicitly to the lowest-order diffractive amplitude for electron-electron scattering, Compton scattering, and photon-photon scattering. A general case $a + b \to a' + b'$ is also discussed. It is found that the scattering amplitude is now factorized and the existence of a Regge pole is suggested. This is then verified by a study of the tower diagrams. Thus the leading singularity in the J plane, while being a pair of branch points for $t \leq 0$, is a moving Regge pole located to the right of $J = \frac{3}{2}$ as t is near $4\lambda^2$. The Gribov paradox is thereby automatically resolved. (auth)

7593 PARTICLE SIZE AND CONTRACTION AT HIGH VELOCITY. Mueller, A. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 2: 2241-54(15 Nov 1970).

The question of size and contraction of size at high velocity is considered in the context of particle physics. Size is defined through a simultaneous interaction with an external potential. To second order in the external potential, one is led to consider matrix elements of the form $\langle p|j_0(x,x_3,0)j_0(0)|p\rangle$. For large p such matrix elements are found to approach $p\delta(x_3)F(x)$ if there are no Regge singularities at J = 1 when t = 0. If there are such singularities at J = 1 when t = 0 and if they recede below J = 1 for negative t, then matrix elements analogous to the one above, but for $t < 0$, approach $\delta(x_3)$ at high velocity. F(x) is related to the residue of a wrong-signature fixed pole at J = 1 in a virtual Compton amplitude. F(x) is also shown to be equal to the second-order impact factor in the operator droplet model. These results are then generalized to an arbitrary number of interactions with the external potential. More singular interactions, where the above analysis breaks down, are considered. It is found that for a certain strength of singularity on the light cone, the particle size may shrink to zero at high velocities. In a large class of models which give the scaling law for deeply inelastic electroproduction and have a constant asymptotic total cross section for electroproduction, it is found that the particle size does not shrink. A converse statement is also found, in that a simple argument shows that if electromagnetic particle size at t = 0 shrinks, then the total symptotic electroproduction cross section vanishes at high energy. (auth)

7594 PHENOMENOLOGICAL PRESENTATION OF THE DIRAC QUANTIZATION OF MAGNETIC CHARGE. Lubkin, Elihu (Univ. of Wisconsin, Milwaukee). Phys. Rev., D; 2: 2510-11 (15 Nov 1970).

The field-dependent difference in phase associated with two paths in an interference experiment employing electrically charged particles of electric charge e is ordinarily proportional to the magnetic flux through a surface bounded by the difference of the paths. If considered as a visible electron-optical fringe displacement, it may be used as a phenomenological support for Dirac's condition $eg = \frac{1}{2}n$, restricting the strength of a magnetic monopole. (auth)

7595 HIGH-ENERGY DELBRUECK SCATTERING CLOSE TO THE FORWARD DIRECTION. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Contract AT(30-1)-4101. Phys. Rev., D; 2: 2444-57(15 Nov 1970).

Delbrück scattering is the elastic scattering of a photon by a static Coulomb field via electron-positron pair creation. At high energies, there are two natural scales for the momentum transfer Δ, namely, m and m^2/ω, where m is the mass of the electron, and ω is the photon energy. When Δ is much larger than the smaller scale m^2/ω, the impact factor representation holds at high energies. The impact picture is here extended to give also the high-energy behavior of the Delbrück scattering amplitude when Δ is comparable to m^2/ω. The result can be expressed in terms of generalized hypergeometric functions, which reproduces the known result in the forward direction when Δ is set equal to zero, and also joins smoothly to the impact factor representation when Δ is much larger than m^2/ω. In the present analysis, the fine-structure constant α is assumed to be small, but not $Z\alpha$. In other words, all terms of the form $\alpha(Z\alpha)^n$ in the amplitude are taken into account. It is also shown that the result for $\Delta \ll m$ is independent of the mass of the target, and hence is in particular applicable to Compton scattering by an electron. (auth)

7596 CURRENT-COMMUTATOR DERIVATION OF MASS-DIFFERENCE RELATIONS. Goyal, Ashok; Li, Ling Fong; Segre, Gino (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 2: 2373-7(15 Nov 1970).

The consequences of the vanishing of certain double commutators are investigated to examine the consistency of SU(3) × SU(3)-breaking models. The contribution to $\Delta I = 2$ mass differences of isospin-violating terms other than the electromagnetic interactions in the Hamiltonian is also calculated. (auth)

7597 STRONG ABSORPTIVE REGGE-CUT MODEL FOR PION PHOTOPRODUCTION, np → pn, AND RELATED PROCESSES. Kane, G. L. (Univ. of Michigan, Ann Arbor); Henyey, F.; Richards, D. R.; Ross, Marc; Williamson, G. Phys. Rev. Lett.; 25: 1519-22(23 Nov 1970).

The combined high-energy data for $\gamma p \to \pi^+ n$, $\gamma n \to \pi^- p$, $np \to pn$, $\bar{p}p \to \bar{n}n$, $\gamma p \to \pi^0 p$, and $\gamma p \to \eta p$ are successfully described in a strong absorptive (Regge-cut) model. Only the high-lying trajectories, ω, ρ, A_2, and (evasive) π and the associated cuts are necessary to understand the data. The $\pi^\pm$ photoproduction cross section difference rules out "nonsense wrong-signature zeros." The scale of the cross sections is determined correctly by the conventional coupling strengths. The general features of pion exchange are discussed. (auth)

7598 EFFECT OF ϵ ($J^P = 0^+$, I = 0) RESONANCE ON $e^+e^- \to \pi^+\pi^-\gamma$. Sarker, A. Q. (Univ. of Oregon, Eugene). Contract AT(45-1)-2041. Phys. Rev. Lett.; 25: 1527-9(23 Nov 1970).

The product of the coupling constants for $\epsilon \to \pi\pi$ and $\epsilon \to 2\gamma$ is estimated from a super-convergent sum rule obtained from the helicity-flip amplitude of pion-Compton scattering. It is then used to show that the contribution of ϵ (even C) to the process $e^+e^- \to \pi^+\pi^-\gamma$ (to order α^3) is about two orders of magnitude larger than that when the pions are in odd-C states. (auth)

7599 FALL DOWN TO THE CENTER AT Z > 137 AND CRITICAL NUCLEAR CHARGE. Popov, V. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 12: 429-47(Aug 1970). (In Russian).

A solution is considered of the Dirac equation for an electron in the Coulomb field with Z > 137, when for the point nuclear charge an "incidence to the center" occurs. Account of a finite size of the nucleus resulting in regularization of the Coulomb potential at $r \to 0$ allows one to deal with charges Z > 137 up to a "critical" value Z_{cr}, such that the ground state energy reaches

the boundary of the lower continuum, $E = -mc^2$. An equation for Z_{cr} is obtained and dependence of Z_{cr} on the nuclear radius R and on the charge distribution inside the nucleus is studied. Mean radius of the ground state is calculated and it is shown that at $Z \to Z_{cr}$ the electron state remains localized, though $\epsilon = E/mc^2 \to -1$ and $\lambda = \sqrt{1-\epsilon^2} \to 0$. Relativistic Coulomb problem is also discussed for particles with spins 0 and 1. (auth)

7600 COMMENTS ON THE LEADING LIGHT-CONE BEHAVIOR IN PHOTOABSORPTION AND ELECTROPRODUCTION. Pestieau, J. (Centro de Investigacion del IPN, Mexico City); Roy, P. Lett. Nuovo Cim.; 4: 1083-7(5 Dec 1970).

It is shown that a previous claim, where the equation for the structure function in deep inelastic electroproduction in the Bjorken scaling limit is valid in the Regge region, is not correct in general, since this limit picks out contributions from inside a portion of the light cone. It is also shown that the claim of the validity of this equation in the general Regge limit leads to a contradiction with the observed behavior of the total photoabsorption cross section at high energies. (J.F.P.)

7601 SUM RULE ANALYSIS FOR THE DECAY AMPLITUDES $\pi^0 \to 2\gamma$, $\eta \to 2\gamma$, AND $X \to 2\gamma$. Fil'kov, L. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 12: 380-5(Aug 1970). (In Russian).

Sum rules for the interaction constants of π^0, η, and X mesons obtained from dispersion relations for the amplitudes of Compton scattering on nucleon, are analyzed. The comparison of the sign of the decay amplitude $\pi^0 \to 2\gamma$ obtained from the above sum rules, with the experiment results in the appearance of an additional quasilocal term depending only on t in the nucleon Compton scattering amplitude. (auth)

7602 POSSIBLE METHODS OF POLARIZATION OF ELECTRONS AT REST IN MAGNETIC FIELD. Loskutov, Yu. M.; Leventuev, V. P. (Moscow State Univ.). Yadern. Fiz.; 12: 368-73(Aug 1970). (In Russian).

The principal possibility is considered for achieving high polarizations for electrons at rest in a magnetic field and exposed to an intense electromagnetic wave. The polarization time dependence on the field intensity, electromagnetic wave frequency and the spectral line width are estimated. (auth)

7603 MEASURING LIGHT-CONE SINGULARITIES. Jackiw, Roman; Van Royen, Roger; West, Geoffrey B. (Massachusetts Inst. of Tech., Cambridge). Contracts AT(30-1)-2098; AT(30-1)-2076. Phys. Rev., D.; 2: 2473-85(15 Nov 1970).

The scaling behavior observed in deep-inelastic electron scattering is related to the structure of the electric current commutation function in position space. It is shown that the experimental data place stringent, but simple, restrictions on the commutator, and that the leading light-cone singularity may be parametrized by the observed asymptotic cross sections. Also a new sum is derived which connects the asymptotic longitudinal cross section with a possible q-number Schwinger term in the equal-time commutator of the electromagnetic current with the charge density. Finally, it is demonstrated that the divergent part of the electromagnetic self-mass of the target proton, to lowest order in electromagnetism, is determined by the total electroproduction cross section. (L.B.S.)

7604 PARTONS AND DEEP INELASTIC PROCESSES AT HIGH ENERGIES. Drell, Sidney D. Comments Nucl. Particle Phys.; 4: 147-53(Jul-Aug 1970).

The discussion of partons and deep inelastic processes covers deep inelastic electron scattering and a brief discussion of p + p and ν + p interactions and hadron production in electron–positron annihilation. The impulse approximation is used for studying these processes. (J.F.P.)

7605 SMOOTHED VENEZIANO-LIKE PION FORM FACTOR. Antoniou, N. G.; Georgalas, C. G.; Kouris, C. B. (Democritus Nuclear Research Center, Athens). Lett. Nuovo Cim.; 4: 915-20(14 Nov 1970).

A smoothed-out expression for the pion electromagnetic form factor in the framework of the Veneziano model is presented. The expression is then used to fit the electron-positron colliding-beam data in the timelike region, and the results are compared with pion electroproduction data in the space-like region. The behavior of the pion form factor in the region of the high-mass resonances is also predicted. (L.B.S.)

7606 LOW-ENERGY ELECTROPRODUCTION AND EQUAL-TIME COMMUTATORS. Furlan, G. (Univ., Trieste, Italy. International Centre for Theoretical Physics, Trieste, Italy); Paver, N.; Verzegnassi, C. Nuovo Cim.; 70A: 247-65(21 Nov 1970).

Low-energy photoproduction and electroproduction of pions are estimated by using equal-time commutators between current densities and divergences and by including low-lying intermediate states. Predictions are presented for charged photoproduction s- and p-wave multipoles, in agreement with experiments and dispersion theory, and for transversal and longitudinal electroproduction cross sections near threshold. The dependence of the results on the axial vector form factor $G_A(t)$ is discussed. (auth)

7607 $\gamma\gamma$ COLLISIONS WITH ALMOST REAL PHOTONS. Jaccarini, A.; Arteaga-Romero, N.; Parisi, J.; Kessler, P. (Coll. de France, Paris). Lett. Nuovo Cim.; 4: 933-7(14 Nov 1970).

It is shown that under certain conditions photon–photon collisions can be produced, at high energy and with reasonably high counting rates, by using the new electron–positron storage rings now under construction. Thus, the materialization of two photons into various particles can be studied, without the need for any special device. Cross-section predictions for muon-, pion-, and kaon-pair creation at 2 and 10 GeV are calculated and compared. (L.B.S.)

7608 EXACT CALCULATION OF THE ANGULAR CROSS-SECTION OF ELECTRON PAIR PRODUCTION. Dugne, J. J.; Proriol, J. (Laboratoire de Physique Nucleaire, Clermont-Ferrand, France. Institut Univ. de Technologie, Montlucon, France). Lett. Nuovo Cim.; 4: 938-40(14 Nov 1970).

An exact calculation of the angular cross section of electron-pair production is made following the method of Overbo and Olsen (Phys. Rev., 175: 1978(1968)). (L.B.S.)

Weak

7609 (CONF-690608–, pp 43-9) REVIEW OF WEAK INTERACTIONS. Steinberger, J. (European Organization for Nuclear Research, Geneva Switzerland). Columbia Univ., New York).

The present understanding of weak interactions is reviewed. Special attention is given to experimental material related to CP violation. The model; the Cabibbo angle; the $\Delta I = 1/2$ rule; the $\Delta S = \Delta Q$ rule; neutrino experiments; astrophysics; the CP violation; and the outstanding problems are some of the subjects involved. In addition to the problem of understanding the source of CP violation, the dominant problem in weak interaction theory is to find means of dealing with higher order and higher energy. The point interaction which forms the basis of all present-day calculations, diverges in higher order, even if intermediate bosons are introduced. Furthermore, at high energies the point interaction violates unitarity. The unitarity difficulty can be removed by the introduction of intermediate bosons. The intermediate boson has, however, not as yet been found. It is possible that the present model is inadequate even at low energies; for instance, there may be neutral currents at a low level which are not included in this model. If, however, the model should be quite correct at low energies, it will be difficult to perform experimental checks on possible higher-order or higher-energy modifications, since present experiments are far from the energy domain where these effects are important. (Sweden)

7610 (IFT–70/6) WEAK PROCESS $\pi^+P \to K^+P$. Kolanewski, Marek (Warsaw Univ. (Poland). Inst. for Theoretical Physics). Mar 1970. 6p. Dep. NTIS (U. S. Sales Only).

An estimate is made for the contribution of the weak interaction $\pi^+p \to K^+p$ to the two-body π^+p scattering. The pole model was used for the calculation of the cross section of the weak process. The result is $\sigma^W/\sigma^{EL} \cong 0.75 \times 10^{-10}$ near the threshold for the weak reaction. (auth)

7611 (JINR–E1-5439) INTERROGATIVES ABOUT NEUTRINOS. Pontecorvo, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 25p. (CONF-700806–50). Dep. NTIS (U. S. Sales Only).

From 15th International Conference on High Energy Physics, Kiev, USSR.

New experiments in neutrino physics and astrophysics are discussed. (auth)

7612 (NYO–1932(2)-184) REMARKS ON THE $|\Delta\vec{I}| = \frac{1}{2}$ RULE IN NON-LEPTONIC WEAK DECAYS. Lee, T. D. (Columbia Univ., New York). Jul 1970. Contract AT(30-1)-1932. 19p. Dep. NTIS.

The soft pion limits for kaon decay amplitudes are reviewed, and it is shown that these soft pion limits do not imply the $|\Delta\vec{I}| = \frac{1}{2}$ rule for the physical nonleptonic kaon decays. Thus the underlying reason for the observed $|\Delta\vec{I}| = \frac{1}{2}$ rule must be due to a different origin. Some speculations on this origin are discussed. (J.F.P.)

7613 VIOLATION OF ADLER'S THEOREM IN SCALAR THEORIES OF WEAK INTERACTIONS. Mani, H. S.; Vaishya,

J. S. (Indian Inst. of Tech., Kanpur). Nucl. Phys.; B24: 231-6(1970).

An experiment using neutrino scattering on nucleons is suggested to distinguish between the recently proposed scalar theory and the usual vector theory of weak interactions. The test is based on Adler's theorem, which states that in inelastic neutrino scattering on nucleons, no parity-violating effects can be seen in the parallel configuration (the direction of the momentum of the emitted lepton and the incident neutrino are same), provided the usual V-A theory with CVC is true. It is found that if the laboratory energy of the neutrino is of the order of the mass of the scalar bosons, substantial violation of the theorem occurs, leading to parity-violating effects. Thus with the laboratory energy of the neutrino being 10 GeV, sizable parity-violating effects of the order of 10% exist if the mass of the scalar boson is 6 GeV. (auth)

7614 NEAR-FORWARD NEUTRINO REACTIONS ON NUCLEAR TARGETS. Bell, J. S.; Smith, C. H. Llewellyn (CERN, Geneva). Nucl. Phys.; B24: 285-304(1970).

A simple model is considered for near-forward neutrino reactions on nuclear targets in the conditions of the CERN experiment. The model accounts for the failure to observe the shadow effect, which is compensated by the elastic interaction and masked by unshadowed terms which grow rapidly away from the forward direction. (auth)

7615 K_{l3} FORM FACTORS, SMOOTHNESS, AND CHIRAL SYMMETRY BREAKING. Komen, G. J. (Univ., Amsterdam). Nucl. Phys.; B24: 305-13(1970).

Two low-energy theorems on the K_{l3} form factors and their "mass-extrapolation" are compared. The dependence on the parameter c, measuring the strength of the SU(3) breaking relative to the SU(2) ⊗ SU(2) breaking is discussed. For $c \approx -0.85$ we obtain $\xi \approx -1.0$. (auth)

7616 MODIFIED HYPOTHESIS OF PARTIALLY CONSERVED AXIAL VECTOR CURRENT, THE PION-DECAY CONSTANT f_A^π AND THE RATIO f_A^π/f_A^K. Satapathy, M. (Laval Univ., Quebec). Nuovo Cim.; 70A: 344-54(1 Dec 1970).

The hypothesis of partial conservation of weak axial vector current is modified to include a pseudoscalar current operator. Invoking this modified hypothesis in the theoretical calculation of the pion-decay constant f_A^π and the ratio of kaon- to pion-decay constants $|f_A^K/f_A^\pi|$ it is found that $f_A^\pi = 0.139 m_p$ and $|f_A^K/f_A^\pi| = 1.28$, which are in excellent agreement with the corresponding experimental value $0.14 m_p$ for f_A^π and the Cabibbo-angle value 1.28 for $|f_A^K/f_A^\pi|$. (auth)

7617 THEORY OF WEAK INTERACTIONS WITH CONTINUOUS-SPIN NEUTRINOS. Iverson, G. J. (Univ. of Miami, Coral Gables, Fla.); Mack, G. Phys. Rev., D; 2: 2326-34(15 Nov 1970).

Among the unitary irreducible representations of the Poincaré group classified by Wigner, there occurs a class of mass-zero representations $O_+'(\rho)$ which has not hitherto been used for the description of known elementary particles. For historical reasons, these are called "continuous-spin" representations. They are labeled by values of the Poincaré $P^2 = 0$, $W^\alpha W_\alpha = -\rho^2$, with $\rho > 0$. It is proposed to assign one or both neutrinos ν_e, ν_μ to such a representation. A corresponding neutrino can exist in a denumerable set of helicity states λ, with λ assuming all half-odd-integer values $\lambda = \pm\frac{1}{2}, \pm\frac{3}{2}, \ldots$. A theory of weak interactions with such continuous-spin neutrinos is presented. It differs from the conventional V − A theory with two-component neutrinos in the form of the leptonic current. The predictions of the latter are approached as a limit when $\rho \to 0$. Explicit expressions for the matrix elements of the new leptonic current are derived. Lepton numbers are conserved if all the neutrinos and antineutrinos are distinct particles. It is, however, also possible in this theory, and consistent with present experimental evidence, to identify either $\nu_e \equiv \bar{\nu}_e$ or $\nu_e \equiv \bar{\nu}_\mu$. Lepton-number-nonconserving processes are then allowed, though suppressed if ρ is small. (auth)

7618 MASS DISPERSION RELATIONS IN THE LIGHT OF THE LIGHT CONE. Brandt, Richard A. (Univ. of Maryland, College Park. Rockefeller Univ., New York); Preparata, Giuliano. Phys. Rev. Lett.; 25: 1530-4(23 Nov 1970).

Operator-product expansions near the light cone are used to study the convergence and saturation properties of some mass dispersion relations. A general formalism is developed and applied to justify partial conservation of axial-vector current and to correct vector-meson dominance. The K_{l3} form factors and the decays $\pi^0 \to \gamma\gamma$, $\omega \to \pi\gamma$, and $\omega \to 3\pi$ are specifically treated. (auth)

7619 SECOND-CLASS CURRENTS IN WEAK INTERACTIONS. Okubo, Susumu (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 25: 1593-6(30 Nov 1970).

A simple way of introducing second-class currents was suggested by naturally incorporating a tensor density in the theory. A possible explanation for large ξ and λ_+ parameters in K_{l3} decays is also proposed. (auth)

7620 LEPTONIC DECAYS OF Λ-^{3}H HYPERNUCLEUS. Lyul'ka, V. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 12: 360-7(Aug 1970). (In Russian).

Leptonic decays of the Λ-^{3}H hypernucleus are considered. The spectra of the ^{3}He recoil nuclei and the angular lepton−neutrino correlation in decays $\Lambda\text{-}^3H \to {}^3He + l^- + \nu$ are calculated. For μ-mesonic decays, the degree of longitudinal and transversal μ-meson polarization in the decay plane is estimated. Λ-^{3}H hypernucleus leptonic decay into four particles is briefly discussed. Probabilities of leptonic decays of Λ-^{3}H nucleus into three and four particles are estimated. (auth)

Strong (General)

7621 (CONF-690608–, pp 53-60) RESONANCE PHYSICS. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics).

A review is given of the present status of the knowledge of whether the physical quarks exist or not. Some of them are summarized as follows. The outstanding success of the quark model was in defining the exotic states where no resonances have been found. The quark model was used to obtain many results which are in good agreement with experiment. These include resonance spectroscopy, high energy scattering and reactions, and electromagnetic and weak couplings. All of these results are in the domain of IBY physics. Despite numerous attempts at dynamical calculations, no useful results in the domain of stu physics have been obtained from the quark model. The stu properties of the quarks; mass, interactions, and scattering amplitudes are completely unknown. These remain as free parameters in any dynamical calculation, leaving the model with no predictive power. There is no convincing theoretical argument against the naive picture of nonrelativistic motion of strongly bound particles in a deep well. Consistent models having this property have been recently found in classical relativistic dynamics. There is no theoretical prediction for the mass of the quark. It does not appear as a parameter in any experimental result predicted for hadron dynamics. Thus, the experimental failure to find the quark can never be convincing evidence against its existence. Exotic resonances; quark model; absence of exotic states versus experimental quantities; and resonance spectroscopy are discussed. (Sweden)

7622 (CONF-690608–, pp 127-40) THEORY OF HADRONIC INTERACTIONS. Jacob, M. (European Organization for Nuclear Research, Geneva (Switzerland)).

A review is given on the duality, with particular emphasis on the present dual models for scattering and production amplitudes; duality, exchange degeneracy and rising Regge trajectories; the Veneziano model; generalization of dual models to production amplitudes; from dual models to a dual theory; multiperipheral bootstrap; and meson dynamics with Padé approximants. Multiperipheral bootstrap and meson dynamics with Padé approximants are discussed. (Sweden)

7623 (ITF-70-12) CONSTRUCTION OF THE CROSSING-SYMMETRICAL AMPLITUDE USING VENEZIANO-LIKE QUASIPOTENTIAL. Enkovski, L. L.; Shelest, V. P.; Struminskii, B. V.; Zinov'ev, G. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 11p. Dep. NTIS (U. S. Sales Only).

A method for the construction of a crossing symmetric scattering amplitude is suggested. The method is based on the quasipotential equation for the scattering amplitude. The asymptotic behavior of the scattering amplitude at high energies $S \to \infty$ was investigated. (auth)

7624 (UCR-34-P-107-113) HADRON SPECTROSCOPY AND HIGH ENERGY SCATTERING IN THE QUARK MODEL. Chylek, Petr (California Univ., Riverside). Mar 1970. 89p. Dep. NTIS.

Thesis.

The Roper resonance is interpreted as a radially excited three-quark state. For its octet counterparts the resonances Σ(1700), Λ(1745) and Ξ(1930) are suggested. Thus, the unusually large widths of these resonances are explained and the spin-parity is predicted to be $\frac{1}{2}^+$. The double-peaked A_2 meson is explained by

the $(q\bar{q})^3$ meson structure. Consequences of this assignment are discussed. The quark model numerical selection rule for three-hadron vertex is derived and a new graphical approach to high energy scattering in the framework of the quark model is suggested. The method is applied to elastic forward meson-nucleon scattering and several reasonably well satisfied relations between total cross sections are derived. The same model is applied to backward meson–nucleon scattering and backward N^*_{33} production. Whenever comparison with experimental data is possible, good agreement is found. The model also gives a connection between the possible violation of the Pomeranchuk theorem and isospin dependence of total cross sections at high energy. (auth)

7625 QUARK DYNAMICS AND DAUGHTER TRAJECTORIES. Squires, Euan J. (Univ. of Durham, Eng.). Nucl. Phys.; B24: 314-16(1970).

It is shown that the heavy quark model, with forces due to meson exchange, and having a linear trajectory, does not have any nearby daughters. (auth)

7626 NONASSOCIATIVITY OF THE OPERATORS IN THE CROSSING-SYMMETRIC BETHE–SALPETER EQUATIONS. Yaes, Robert J. (Univ. of Texas, Austin). Phys. Rev., D; 2: 2457-63 (15 Nov 1970).

The properties of the crossing-symmetric Bethe-Salpeter equations which have been proposed by Taylor and by Haymaker and Blankenbecler are discussed. Various possible methods of solution and the possibility of application to the Veneziano amplitude are considered. It is shown that the operators which appear in these equations are not mutually associative, and hence that even the linearized approximation to these equations cannot be solved by conventional techniques. (auth)

7627 POMERANCHUK-LIKE THEOREM THAT CAN BE PROVED. Kinoshita, Toichiro (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 2: 2346-8(15 Nov 1970).

Assuming that the total cross sections tend to finite nonvanishing limits as $s \to \infty$, it is shown in axiomatic field theory that the scattering amplitudes $f_1(s,t)$ and $f_2(s,t)$ for processes $A + B \to A + B$ and $\bar{A} + B \to \bar{A} + B$ must satisfy either or both of the relations $\sigma_1(s)/\sigma_2(s) \to 1$ and $[d\sigma_1(s,t(s))/dt]/[d\sigma_2(s,t(s))/dt] \to 1$ as $s \to \infty$, where σ_i and $d\sigma_i/dt$ are the total and elastic differential cross sections and $t(s) = -C(\ln s)^{-2}$. Since σ_i and $d\sigma_i/dt$ are both measurable, this result allows axiomatic field theory to be subjected to an experimental test. (auth)

7628 PREDICTIONS FOR HIGH-ENERGY ELASTIC AND INELASTIC SCATTERINGS IN φ^3 THEORY. Chang, Shau-jin (Univ. of Illinois, Urbana. Stanford Univ., Calif.); Yan, Tung-mow. Phys. Rev. Lett.; 25: 1586-90(30 Nov 1970).

High-energy elastic and inelastic processes are studied in a φ^3 theory based on the s-channel iterations of t-channel ladder diagrams. The main results are the following: The total cross section goes to zero, a constant, or $\sim(\ln s)^2$ for the coupling constant being smaller than, equal to, or larger than a critical value. Inelastic differential cross sections are computed and the s-channel unitarity is explicitly verified. One-particle spectrum, multiplicity, number distribution, etc. are presented. The implications of these results to hadron physics are discussed. (auth)

7629 MODELS OF ELEMENTARY PARTICLES. Feld, Bernard T. A Blaisdell Book in the Pure and Applied Sciences. Waltham, Mass.; Blaisdell Publishing Company (1969). 558p. $19.95.

A phenomenological-modelistic approach to the study of particle and high-energy phenomena is presented. Topics discussed include classification of particles and resonant states, kinematics of high-energy reactions, phase-space considerations, S-matrix theory, angular momentum conservation, isotopic-spin conservation, K_1^0–K_2^0 phenomena, electron scattering and nucleon form factors, dispersion relations, two-body reactions at high energy, early models of elementary particles, computation of static hadron properties, SU(3), quark model and SU(6), quark model with orbital angular momentum, and weak interactions. Useful appendices and an author and subject index are included. (C.E.S.)

7630 POMERANCHUK-POLE EXCHANGE IN REACTIONS WITH PRODUCTION OF PARTICLES FROM THE SAME ISOMULTIPLET. Dumbrais, O. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 12: 386-8(Aug 1970). (In Russian).

The hypothesis of the Pomeranchuk-pole exchange at high energies results in simple isotopic relations for reactions with production of several particles from the same isomultiplet. Some examples are considered. (auth)

7631 WHAT IS DUALITY? Schmid, D. (CERN, Geneva). Proc. Roy. Soc. (London), Ser. A; 318: 257-78(8 Sep 1970).

From Proceedings of the Royal Society, London, England. See CONF-700916.

Duality gives a satisfying connection between two different areas of strong interaction physics, Regge poles at high energy and resonances at low energy. This interlocking gives powerful bootstrap conditions, and together with the assumption that certain channels do not contain resonances it gives strong restrictions on the hadron spectrum. Since there is some confusion about the term duality, an explanation is given of what is meant by the various forms of duality (f.e.s.r. (finite energy sum rules) duality, local duality), and what is meant by "building up," and it is shown in what way antidual models (such as the generalized interference model) come into conflict with basic empirical facts. (auth) (UK)

7632 WHAT IS RESONANCE? Dalitz, R. H. (Oxford Univ.); Moorhouse, R. G. Proc. Roy. Soc. (London), Ser. A; 318: 279-98 (8 Sep 1970).

From Proceedings of the Royal Society, London, England. See CONF-700916.

The concept of duality, refers to the notion that the analysis of an S matrix amplitude in terms of s channel resonances and its analysis in terms of t channel (and u channel) reggeon exchanges are not independent, but represent alternative descriptions, the former being the more appropriate in the low energy domain and the latter being the more appropriate in the low t (or low u) domain for high energy interactions. Hence it appears necessary to attempt to clarify the notion of resonance, since there has been a good deal of discussion about how partial wave analyses of scattering data should be interpreted in terms of resonance states and even whether such an interpretation was necessarily the case at all. There is essentially no ambiguity about the relation between resonances and poles in the limiting case where the models are confined to the cases of resonances with zero width characterized by poles on the real s axis. Isolated resonance states, isolated reggeon states and the criterion of time delay in collision are discussed. Attention is drawn to examples of resonance bumps in the scattering and reaction processes of meson–baryon interactions and possible comparisons of the properties of those with the requirements of SU(3) symmetry made. (UK)

7633 VENEZIANO THEORY. Lovelace, C. (CERN, Geneva). Proc. Roy. Soc. (London), Ser. A; 318: 321-54(8 Sep 1970).

From Proceedings of the Royal Society, London, England. See CONF-700916.

Recent progress in Veneziano theory is reviewed. Topics discussed include the harmonic oscillator formalism, factorization properties, Olesen's cure of the loop divergence, precedents for dual models in nuclear physics, phenomenology with 5-point functions, experimental evidence against planar duality diagrams. "Classical" Veneziano, such as the theory of meson–meson scattering, is treated more briefly since it has been so much reviewed already. (auth) (UK)

7634 DUALITY AND THE POMERANCHUK SINGULARITY. Harari, H. (Weizmann Inst. of Science, Rehovoth, Israel). Proc. Roy. Soc. (London), Ser. A; 318: 355-78(8 Sep 1970).

From Proceedings of the Royal Society, London, England. See CONF-700916.

The role played by the Pomeranchuk singularity within the framework of the duality scheme is reviewed. (auth) (UK)

7635 ANALYTIC REGULARIZATION IN THE LEE MODEL WITH POSITIVE DEFINITE AND INDEFINITE METRIC. Grosser, D. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 70A: 213-32(21 Nov 1970).

Analytic regularization is applied to the Lee model without a cut-off function. The cases of positive definite and indefinite metric are considered. The V-particle propagator is computed in the interaction picture with the help of perturbation theory and subsequently analytically regularized. Four distinct cases corresponding to different values of the parameters introduced can be identified. If the metric is positive definite, contradictions show up in every case. In one case the regularized propagator is equivalent to the propagator given by the usual renormalization. If the metric is indefinite, no contradictions show up. In one case (dipole ghost case) it is shown that the regularized propagator is equivalent to the propagator which one obtains by introducing a cut-off $\hat{\omega}$ and performing the limit $\hat{\omega} \to \infty$ at the end. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 7700, 7701, and 7726.

7636 (CONF-690608–, pp 191-222) ANTIPROTON REACTIONS. Montanet, L. (European Organization for Nuclear Research, Geneva (Switzerland)).

The present status of the field of nucleon-antinucleon interactions ($N\bar{N}$) are summarized under the following aspects: cross sections; elastic scattering and charge exchange; production of pions without annihilation; annihilation; $Y - \bar{Y}$ production; direct s-channel effects-formation of meson resonances; annihilation at rest. New measurements on 2-body annihilations, in particular $\bar{p}p \rightarrow \pi^+\pi^-$ and $\bar{p}p \rightarrow K^+K^-$ show that these reactions have an extremely complex behavior between 0 and 2 GeV/c, indicating very likely the presence of several resonating states. On the other hand the differential cross sections of these reactions at $\cos\theta = \pm 1.0$ were related in a simple way to the backward π^+p and K^+p elastic scattering, indicating, apparently, a more general relation than those obtained from a reggeized baryon exchange model. The multi-body annihilations were analyzed with some success, using the CLA model as applied to $N\bar{N}$ with nucleon exchanges: the results are surprisingly good, considering the crudeness of the model, and indicate that it is certainly a good starting point for a more elaborate analysis of these multi-body annihilations. Direct s-channel effects are being investigated in the 0 to 2 GeV/c momentum region for several final states. All the channels analyzed in some details ($\bar{p}p$ backward scattering, $\bar{p}p \rightarrow \pi^+\pi^-$, $\bar{p}p \rightarrow K^+K^-$) show that these direct s-channel effects are certainly important in the energy region considered. Preliminary bubble chamber results on final states like $pp\pi$, $K\bar{K}\pi$, $K\bar{K}\omega$ give the same complex image but will require a tremendous measuring effort to reach conclusive results. New interpretations of annihilations at rest, due to the Veneziano formalism, have been obtained for $N\bar{N} \rightarrow 3\pi$ and data are available in this field. (Sweden)

7637 (CONF-690608-, pp 387-409) RESONANCE MODELS. Greenberg, O. W. (Tel Aviv Univ. (Israel). Dept. of Physics and Astronomy. Maryland Univ., College Park. Dept. of Physics and Astronomy).

Theories on resonance models are reviewed under the subheadings; remarks on duality; duality and mesons; quark- and other models for mesons; quark model for baryons; and duality and baryons. (Sweden)

7638 (DEMO-70/17) A SMOOTHED VENEZIANO-LIKE PION FORM-FACTOR. Antoniou, N. C.; Georgalas, C. G.; Kouris, C. B. (Democritus Nuclear Research Center, Athens (Greece)). Sep 1970. 14p. Dep. NTIS (U. S. Sales Only).

A smoothed out expression for the pion form factor is introduced. The expression is used to fit the electron–positron colliding beam data in the time-like region. These results are compared with pion electroproduction data in the space-like region. The behavior of the pion form factor in the region of the high-mass resonances is predicted. (J.F.P.)

7639 CONSTRAINTS IMPOSED ON $\pi\pi$ PARTIAL WAVES BY POSITIVITY. Pennington, M. R. (Westfield Coll., London). Nucl. Phys.; B24: 317-38(1970).

In a recent paper closed integral expressions were obtained for the crossing constraints on $\pi\pi$ partial-wave amplitudes. These are now used together with the positivity property of the absorptive part of the scattering amplitude to obtain further constraints on the lower partial waves. (auth)

7640 $\pi\omega \rightarrow \pi A_1$ PROCESS IN THE VENEZIANO MODEL. Caprini-Gologan, I.; Micu, L. (Inst. for Atomic Physics, Bucharest). Nuovo Cim.; 70A: 355-72(1 Dec 1970).

The possibility of writing Veneziano formulas for the amplitudes of the process $\pi\omega \rightarrow \pi A_1$ is investigated. It is found that the asymptotic behavior of the invariant amplitudes, the positions of the lowest poles, the elimination of parity doubling on the leading trajectories, the factorization properties of the Regge residues and the Adler condition can be consistently imposed and considerably reduce the number of arbitrary parameters. Using a current algebra technique in the soft-pion limit, a Veneziano-like expression for the pseudoscalar-vector-vector vertex is deduced. The result is consistent with the hypothesis of the meson dominance of the vectorial current. (auth)

7641 FACTORIZATION OF $M^J\pi \rightarrow M'^J\pi$ RESIDUES WITHIN THE VENEZIANO MODEL. Jacobs, Matthew A. (Tel-Aviv Univ., Israel). Phys. Rev., D; 2: 2431-9(15 Nov 1970).

The reactions $M^J\pi \rightarrow M'^J\pi$ are analyzed for a class of mesons, M^J. Imposing the Veneziano form in one channel, the Regge residues at poles are required to satisfy factorization conditions. These conditions are expressed in terms of the residues of the invariant amplitudes of the processes, for various hypotheses about the spacing of contributing trajectories of opposite normality. It is found that factorization in one channel only is consistent with the coupling of the lowest-spin kinematically allowed particles in each helicity amplitude. (auth)

7642 NONINVARIANT AMPLITUDES IN DUAL CONSTRUCTIONS. Canning, Gerald P. (Tel-Aviv Univ., Israel). Phys. Rev., D; 2: 2426-30(15 Nov 1970).

The satisfaction of the leading trajectory factorization constraints is examined in the context of duality as expressed by the Veneziano model. It is found that amplitudes are best constructed using a larger dependent set of amplitudes linearly related by non-numerical coefficients. Some amplitudes are required to be effectively leading in one channel but not in a crossed channel. The discussion is centered on the example $A_1\pi \rightarrow \omega\pi$. (auth)

7643 STABILITY TEST FOR THE EQUIVALENT-POTENTIAL METHOD UP TO FIRST ORDER. DerSarkissian, M. (Freie Univ., Berlin, Temple Univ., Philadelphia). Lett. Nuovo Cim.; 4: 1058-62(5 Dec 1970).

The equivalent-potential method, which was previously proposed as an alternative to the N/D method, is studied. It is shown that a previously proposed iterative procedure for generating the equivalent potential in higher order, given the lowest-order equivalent potential, is unstable. The instability is closely related to the singularity (at $s = (\pi\pi \text{ c.m. energy})^2 = 0$) in the equivalent potential. (J.F.P.)

7644 $E-\eta$ MIXING AND RADIATIVE DECAYS OF MESONS. Zaslavskii, A. N.; Tybor, V. (Inst. of Physics, Erevan). Yadern. Fiz.; 12: 376-9(Aug 1970). (In Russian).

Consequences from $E-\eta$ mixing are discussed assuming that the ninth member of the pseudoscalar nonet is the E(1420) meson. Decay widths for $E \rightarrow 2\gamma$, $E \rightarrow \rho\gamma$, $E \rightarrow \omega\gamma$ calculated in various models, are presented. The most preferable value of $\Gamma(E \rightarrow 2\gamma)$ ~200–300 KeV is found to be rather large; and the width of $E \rightarrow \rho\gamma$ decay is about 10 MeV. Detection of the $E \rightarrow 2\gamma$ decay would definitely establish that the E meson is pseudoscalar; and study of the radiative decays of the E meson would help to choose the correct model. (auth)

7645 PROPERTIES OF CROSS SECTION OF THE PROCESS $p^-p \rightarrow e^+e^-$ ($\mu^+\mu^-$) WITH POLARIZED INITIAL PARTICLES. Khoze, V. A. (Inst. of Physics, Erevan). Yadern. Fiz.; 12: 374-5(Aug 1970). (In Russian).

The dependences of cross section of the process $p^-p \rightarrow e^+e^-$ ($\mu^+\mu^-$) on the initial particles polarizations are analyzed on the basis of considerations of invariance under rotations and reflections, CP parity and conservation of chirality of ultrarelativistic electrons. (auth)

7646 BROKEN SCALE INVARIANCE AND $\sigma\pi\pi$, $A\sigma\pi$, AND σAA VERTICES. Kleinert H. (Freie Univ., Berlin); Weisz, P. H. Lett. Nuovo Cim.; 4: 1091-6(5 Dec 1970).

It is pointed out that knowledge of the dimension of the scalar operator is sufficient to determine the free constants and thus to fix the ratios for coupling constants $g_{A\sigma\pi}/g_{\sigma\pi\pi}$ and $g_{\sigma AA}/g_{\sigma\pi\pi}$. (J.F.P.)

7647 MESON–MESON SCATTERING LENGTHS FROM CHIRAL $SU_2 \times SU_2$ EFFECTIVE LAGRANGIANS. Bose, S. K. (Univ. of Manchester, Eng.); Ndili, F. N. Lett. Nuovo Cim.; 4: 1097-1102(5 Dec 1970).

The problem of the $\pi\pi$ scattering lengths calculated by the effective Lagrangian method is considered. SU(2) × SU(2) chiral symmetry is used in these calculations. (J.F.P.)

7648 RESONANCE STATES OF THE πK SYSTEM AND LOW-ENERGY πK SCATTERING. Isaev, P. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 12: 389-400(Aug 1970). (In Russian).

Dispersion relations are obtained for s and p waves of the πK scattering with account of contributions from high energies by means of the Shirkov–Serebryakov method. Analysis of the present data on low-energy πK scattering is carried out on the basis of the dispersion relations. The domain of applicability of the quasistatic approach is estimated. (auth)

7649 RESONANCE RECOGNITION IN A VENEZIANO MODEL. Phillips, R. J. N.; Ringland, G. A. (Rutherford High Energy Lab., Chilton, Eng.). Proc. Roy. Soc. (London), Ser. A; 318: 299-306(8 Sep 1970).

From Proceedings of the Royal Society, London, England. See CONF-700916.

On the assumption that a resonance is a second-sheet pole in s of a partial wave amplitude T^J: $T^J(s) = B^J(s) + R^J/(s_R^J - s)$, Where s_R is the pole position ($\text{Im}s_R < 0$), R^J is the residue and $B^J(s)$ is everything else ("background") then a narrow resonance gives a circular arc in the Argand plot of $T^J(s)$. Similar arcs are found experimentally, but it is still not agreed exactly how to get resonance parameters from them. Many criteria have been suggested:

XUM

top of the loop; maximum modulus; maximum velocity; Schmid loops; interference model. It is suggested that for the most prominent resonances all criteria give good results, that the velocity criterion is consistently good, until resonances overlap strongly, that the modulus criterion is not very reliable (though the modulus plot shows the strong resonances, the less pronounced appear as shoulders or disappear altogether), that the ImT criterion works surprisingly well in many cases, although the usual justification — real residues — is not true in general, that none of the criteria work for the Schmid loops, excepting the resonances on the leading trajectory, approximately given by the ImT and |T| criteria, that there is a vague resemblance between the Schmid loops but it is clear that local duality does not hold in our model. It is not surprising that the interference model gives poor results here, since the Veneziano model is globally dual. (UK)

7650 HIGH-ENERGY SCATTERING. I. Low, F. E. Comments Nucl. Particle Phys.; 4: 154-8(Jul-Aug 1970).

The total cross sections and the Moeller amplitude are discussed for $\pi^0 + \pi^0$ interactions. Various types of the high-energy behavior of the Moeller amplitude are given in terms of singularities in the angular-momentum plane. (J.F.P.)

7651 CONSTRAINTS ON PARTIAL WAVE AMPLITUDES FROM THE FROISSART–GRIBOV REPRESENTATION. Cronstroem, C. (Inst. for Advanced Study, Princeton, N. J.). Ann. Phys. (N. Y.); 61: 98-118(Nov 1970).

It is shown that if a sequence $a_l(s)$ of partial wave amplitudes satisfies a Froissart–Gribov representation, with a power bounded weight function, for $l \geq N$, where N is a nonnegative integer, then the amplitudes $a_l(s)$ for $l \geq N$ are constrained by an infinite set of algebraic inequalities, each inequality involving an infinite number of partial wave amplitudes. The discussion is limited to the case of scattering of spinless scalar particles. (auth)

7652 COMMENTS ON THE BROKEN EXCHANGE-DEGENERATE REGGE-POLE MODEL FOR np AND $p\bar{p}$ CHARGE EXCHANGE. Pal, B. K. (Univ. of California, Berkeley). Lett. Nuovo,Cim.; 4: 913-14(14 Nov 1970).

It is shown that in the np and $p\bar{p}$ charge-exchange broken exchange-degenerate Regge-pole model the factorization difficulties resulting from the conspiracy hypothesis can be avoided if an M = 0 pion singlet and an M = 1 pion parity doublet are considered simultaneously. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstracts 7550 and 7701.

7653 (CONF-690608–, pp 143-64) PION REACTIONS. Dilella, L. (Columbia Univ., New York).

A review is given on the recent state of the art problems related to total cross section; characteristics at high energy; coherent interactions; elastic scattering and charge exchange; polarization; quasi-two-body final states; and many-body states. (Sweden)

7654 (CONF-690608–, pp 341-83) STRANGE BARYON RESONANCES. Levi Setti, R. (Chicago Univ., Ill.).

Baryon strange resonances are reviewed under the subheadings; baryon SU(3); S = −1 formation; $\bar{K}N$ data and dispersion relations; S = −1 baryon production; S = −2 baryons; search for S = +1 baryon; and baryon spectroscopy in perspective. (Sweden)

7655 (DESY–70/53) ON THE PHASE OF THE ϕ–NUCLEON FORWARD SCATTERING AMPLITUDE. Krammer, Margarete (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1970. 8p. Dep. NTIS (U. S. Sales Only).

The ratio of real and imaginary parts for the ϕ-nucleon elastic scattering amplitude in the range 7 to 15 GeV/c was calculated to be $\alpha = -0.3 \pm 0.45$, using the additive quark model with isospin symmetry. (L.B.S.)

7656 (IFT–70/5) LOW, INTERMEDIATE, AND HIGH ENERGIES IN THE VENEZIANO MODEL FOR THE KN SCATTERING. Namyslowski, Jozef; Rek, Zbigniew; Swiecki, Michal (Warsaw Univ. (Poland). Inst. for Theoretical Physics). Feb 1970. 22p. Dep. NTIS (U. S. Sales Only).

The low energy constraints — consistency of two Adler–Weisberger sum rules, the Adler requirement, and the isospin-zero KN scattering length equal zero — are built in the Veneziano type model, with no unobserved parity doublets of particles with spin = $^3/_2$, and no unobserved daughters of $Y^*(1382)$. Predictions of the uniquely defined KN amplitude are checked with the experimental data for the S_{11}, P_{11}, P_{13}, and D_{13} K^+p phase shifts, the elastic widths of resonances, differential cross sections of the charge–exchange process $K^+n \rightarrow K^0p$, and the elastic backward K^+p scattering, at energies ranging from threshold up to 12.3 GeV. A reasonable qualitative agreement is found at all energies. (auth)

7657 (JINR–P1-4926) INTEGRAL EQUATIONS OF THE CASCADE KINEMATICS. Grishin, V. G.; Kopylova, D. K.; Kopylov, G. I.; Lyubimov, V. B.; Yuldashev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 36p. (In Russian). Dep. NTIS (U. S. Sales Only).

The case is considered when in the cascade decays the effective masses of two groups of particles from different branches of cascades are measured. Two-dimensional distributions of these values are characterized by the internal structure: the lines of their level are determined by the cascade kinematics (laws of conservation) and not by the effective mass spectrum of the whole system of particles. The similar structure is possible also in the two-dimensional energy distribution. A notion of the kinematic potential-function of one variable, determining two-dimensional representations, is introduced. The integral equations are derived which allow one to determine the spectrum m_{eff} of the whole system of particles without detection of all the final products. With the help of these equations the spectrum $m(\pi^+\pi^-\pi^0)$ is reproduced over $m(\pi^+\pi^-\gamma)$ and $m(\pi^+\pi^-)$ measurements. (auth)

7658 (JINR–P2-5331) ANGULAR AND ENERGY DISTRIBUTIONS OF PARTICLES PRODUCED IN THE INELASTIC π–N AND N–N COLLISIONS AT SUPER-HIGH ENERGIES. Barashenkov, V. S.; Eliseev, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

For the energies more than several dozens of GeV an analytical approximation of the experimental angular and energy secondary particle distributions in the c.m.s. is obtained. This approximation is conveniently applied for calculation of the intranuclear cascades at super-high energies according to the Monte-Carlo method. (auth)

7659 (NP–18533) PHOTON SPECTRUM IN RADIATIVE Ω^--DECAYS. Burlacu, L.; Raszillier, I.; Stamatescu, I. O. (Bucharest Univ. (Romania). Dept. of Theoretical Physics). Jun 1970. 15p. Dep. NTIS (U.S. Sales Only).

The photonic spectrum in the three radiative decays of $\Omega^- \rightarrow K^-\Lambda\gamma$, $\pi^-\Xi^0\gamma$, $\pi^0\Xi^-\gamma$. In the first two the (relative) decay rates for both pure parity-conserving and parity-violating nonradiative vertices are insensitive to the values of electromagnetic multipoles, at least for not too high frequencies, where one expects the Born terms to dominate. In the third decay, on the contrary, they depend very much on the Ω^- magnetic moment, for which (theoretical) predictions allow a wide range of values. (auth)

7660 (NP–18553) S-MATRIX CALCULATIONS OF THE PION–NUCLEON P-WAVE SCATTERING LENGTH a_{13} BY THE N/D METHOD. Sachl, V. F. (Ceskoslovenska Akademie Ved, Prague. Fysikalni Ustav. Durham Univ. (England). Dept. of Mathematics). 1970. 17p. Dep. NTIS (U. S. Sales Only).

In the effective-range approximation for the P-wave scattering process of pions on nucleons the S-matrix calculations are carried out with the help of the N/D method. According to the Balázs method the numerator function is considered in a three pole approximation with two unknown residues $/b_i, i = 1,2/$ and one known, which is chosen in the nucleon pole. In calculations for that purpose the contributions of discontinuities of the ρ-meson, the π-meson–nucleon /3,3/ isobar N^* and the high-energy contributions in the crossed channels and the nucleon pole in the direct channel are taken as the input values. The matching procedure is the usual one: By the projections of invariant amplitudes, which are given with the aid of the fixed s dispersion relations in a regular point s_R of the unphysical region, the right-hand side of one of the determining equations for the effective range parameters b_i is analytically established. Then their fully determining equations are achieved in the matching point s_R through the comparison of these projections and their first and higher derivatives with the N/D representation and its first and higher derivatives on the other side, respectively. On the basis of the noncorrelated physical parameters $/g^2, m, W_R^{33}, \mu/$ and by means of the parameters b_i and in the so derived effective-range N/D amplitude of the state $I = ^1/_2$, $J = ^3/_2$ the P-wave scattering length a_{13} is then calculated. The value of the determined π-meson–nucleon scattering length $a_{13} = -0.019$ is in excellent agreement with the experimental value. (auth)

7661 MODEL RELATING THE POMERON TO THE f^0 MESON AND ITS TEST IN PION–NUCLEON SCATTERING. Achuthan, P.; Schlaile, H.-G.; Steiner, F. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B24: 398-416(1970).

The possibility of an intimate relationship between the f^0 meson and the pomeron is investigated in the framework of dispersion

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theory. As a direct check of the model the total $\pi^{\pm}p$ cross sections at energies up to 65 GeV are predicted in good agreement with the recent Serpukhov data. Also the differential cross sections and polarization parameters for $\pi^{\pm}p$ are shown to agree fairly well with the recent experimental results. In addition to the f^0 trajectory the ρ and ϵ trajectories have been included. Using Oehme's approach for treating the Regge exchange by dispersion relations the result that the s-channel helicity is conserved in πN scattering is obtained as a direct consequence of the model. (auth)

7662 DUAL DIFFRACTIVE MODEL FOR THE Q- AND L-MESONS. Bartsch, J. (Technische Hochschule, Aachen); Schulte, R.; Steinberg, R.; (and others). Nucl. Phys.; B24: 221-30(1970).

The contribution to the reaction $K^-p \to pK^-\pi^+\pi^-$ due to pomeron exchange is studied, assuming that the system (pomeron + mesons) is described by a dual five-point Veneziano-type amplitude. The calculations are compared with the experimental results at 10 GeV/c and good agreement is obtained for the $K\pi\pi$ mass distribution, the t-dependence of the differential cross section and the Dalitz plots for the $K\pi\pi$ systems in the mass regions of the Q- and L-mesons. (auth)

7663 PRODUCTION AND DECAY OF THE A_2 MESON IN 7 GeV/c π^-p INTERACTIONS. Johnston, T. F. (Univ. of Toronto); Key, A. W.; Prentice, J. D.; (and others). Nucl. Phys.; B24: 253-72(1970).

The production and decay of the A_2 meson was studied in a 3.3 events/μb, 7 GeV/c π^-p bubble chamber experiment. The cross section for $\pi^-p \to A_2^-p$ was found to be 120 ± 25 μb. The reaction $\pi^-p \to A_2^-\pi^0p$ was also observed. The alignment of the A_2^- is consistent with the hypothesis that the production is due mainly to ρ-exchange. The $\rho\pi$ decay distributions favor a 2^+ spin parity assignment for both the lower and upper parts of the A_2. The $\eta\pi$ decay distributions for the whole A_2 region are also consistent with $J^P = 2^+$. (auth)

7664 FORWARD STRUCTURE OF CERTAIN SINGLE-PION PRODUCTION REACTIONS. Contogouris, A. P.; Gaskell, R.; Svec, M. (McGill Univ., Montreal). Nucl. Phys.; B24: 237-47(1970).

In terms of (i) a Regge-cut model and (ii) a Veneziano model it is shown that the transverse helicity-frame differential cross section for $\pi^-p \to \rho^0n$ has a sharp forward peak; and that this offers a new verification of ρ-universality. The forward structure of recent data on $\pi^-p \to \pi^0\pi^0n$ is also analyzed. (auth)

7665 SELF-CONSISTENT STRONG-COUPLING MODEL OF THE NUCLEON. II. Krass, Allan S. (Univ. of California, Santa Barbara). Phys. Rev., D; 2: 2464-73(15 Nov 1970).

The nonrelativistic strong-coupling theory with a recoiling source presented in an earlier paper is examined in greater detail. The self-consistent calculation is extended to include a full treatment of the bound field problem instead of the approximation of small oscillations about a constant equilibrium value. The approximations of nonrelativistic fermion kinematics and fermion eigenstates of definite angular momentum are examined carefully and found to be inconsistent. The conclusion is that the oversimplified model discussed in the first paper is not realistic. A program for modifying the model to include relativistic kinematics and angular correlations is proposed. (auth)

7666 NONCAUSAL DISPERSION RELATIONS AND A FUNDAMENTAL LENGTH. Creutz, Michael; Jaffe, Robert (Stanford Univ., Calif.). Phys. Rev., D; 2: 2359-62(15 Nov 1970).

The use of dispersion relations, modified to violate causality, is studied as a tool to limit a fundamental noncausal length. It is found that unless the usual dispersion relations are found to be violated, noncausal dispersion relations give no new information. This means that the only presently believable limit on a noncausal length is given by dimensional analysis. (auth)

7667 MESON–BARYON INTERACTIONS WITH BARYONS BELONGING TO THE NONLINEAR REPRESENTATIONS OF CHIRAL U(3) ⊗ U(3). Soln, Josip (Univ. of Wisconsin, Milwaukee. Univ. of Illinois, Chicago). Phys. Rev., D; 2: 2404-13 (15 Nov 1970).

A general chiral U(3) ⊗ U(3) phenomenological Lagrangian is derived for the meson-baryon system. The meson-baryon derivative coupling is discussed in detail, and K-N scattering is studied. Some renormalized meson-baryon coupling constants are computed and compared with experiments. A suitable canonical transformation is introduced, and conditions under which it yields the Yukawa coupling are discussed. (auth)

7668 $K_L \to K_S$ REGENERATION PHASE IN REGGE MODELS. Barger, V. (Univ. of Hawaii, Honolulu); Phillips, R. J. N. Contract AT(11-1)-881. Phys. Lett.; 33B: 425-8(23 Nov 1970).

The energy dependence of the $K_Lp \to K_Sp$ regeneration phase, found in preliminary results from Serpukhov, is not so anomalous as it seems at first. Several Regge mechanisms–notably $\rho-\omega$ pole cancellation, terms that violate the Pomeranchuk theorem, and complex trajectories–do predict a phase rotation, in the direction observed, and can be adjusted to give approximate agreement with the new data. Future measurements of total cross section differences and regeneration can discriminate between the mechanisms. (auth)

7669 INELASTICITY AND N/D CALCULATIONS. Bart, George Raymond. Chicago; Illinois Inst. of Tech. (1970). 135p. University Microfilms Order No. 70-13,560.

Thesis.

Three major areas are studied. The first relates to a Reggeized N/D approach in which the left-cut term and elasticity are determined at high energies to be consistent with partial wave projections of Regge type amplitudes. The N/D integral equation is Fredholm in this case. An asymptotic analysis of this equation yields the surprising result that the N/D solution will have the same behavior as the input Regge amplitude if and only if the subtraction constant of the partial wave dispersion relation, or an equivalent constant, satisfies a simple linear constraint. For the second area of study, amplitudes are considered which have negligible left-cut contributions to the N/D potential function. The presence of a narrow dip in the elasticity is shown to yield an N/D solution with a circular Argand plot which corresponds to the Breit–Wigner case of a highly inelastic resonance. The connection between the N/D approach in this case and the Ball–Frazer model is explained and the first relatively successful application of the simple Ball–Frazer formula is given. Difficulties associated with completely ignoring the left-cut are illustrated in the case of the π-ND_{13} wave. The difficulties may be overcome in the N/D method by using an empirical potential. The π-NP_{11} state is the last area of study. An evaluation of the left-cut term using experimental phase shift information is shown to yield values in good agreement with those obtained by using crossing relations. When this empirical potential and the experimental elasticity are used as input to the inelastic N/D equations, the output phase shift agrees with experiment up to 2 GeV if and only if at least two Castillejo–Dalitz–Dyson poles are included in the canonical D function. This result rules out single channel bootstrap models and furnishes a constraint on many channel models of the P_{11} state. It also indicates the experimental relevance of a finite energy Levinson relation. (Diss. Abstr. Int., B)

7670 EXISTENCE AND UNIQUENESS OF SOLUTIONS TO THE LOW EQUATION. McDaniel, Harlan Simm. Chicago; Illinois Inst. of Tech. (1970). 128p. University Microfilms Order No. 70-13,562.

Thesis.

Fixed point theorems are used to show that certain crossing symmetric S-matrix equations have at least one solution. The methods are illustrated in the case of the one-meson Low equation. It is shown to have a nonresonant iterative solution which is unique within a certain set of functions. The solution is analytic in a circle in the complex coupling constant plane. Existence proofs are also given for solutions to the inverse amplitude and N/D formulations of the Low equation. It is proved in each of these three formulations that a sufficient condition for the existence of a solution is that the coupling constant be less than a certain bound which depends on the cutoff and on the crossing matrix. The proofs work for an arbitrary $n \times n$ crossing matrix with weak conditions on the cutoff function (for instance, $v(k) = O(k^{-\frac{1}{2}} \ln^{\epsilon} k)$, $k \to \infty$). Resonant solutions are studied by explicit introduction of CDD poles into the N/D equations. Existence of a solution involving an arbitrary choice of narrow resonances can be proved. Numerical values are given for the bounds (for πN scattering and a particular cutoff function) in each of the three formulations of the Low equation. (Diss. Abstr. Int., B)

7671 RESONANCE INTERPRETATION OF PHASE SHIFT ANALYSES AND THE GENERALIZED INTERFERENCE MODEL. Donnachie, A. (Univ. of Glasgow). Proc. Roy. Soc. (London), Ser. A; 318: 307-20(8 Sep 1970).

From Proceedings of the Royal Society, London, England. See CONF-700916.

The phase-shift analyses of πp, $\bar{K}p$ and Kp scattering are discussed in terms of resonance states. The properties of these states are briefly reviewed, in particular their interrelation via the symmetric quark model (or SU(6) × O(3)). The generalized interference model is introduced as a natural way in which to describe the results. (auth) (UK)

7672 S-WAVE K^+p PHASE SHIFT IN THE BOUNDARY CONDITION MODEL. Carreras, B. (Daresbury Nuclear Physics Lab., Eng.). Lett. Nuovo Cim.; 4: 921-3(14 Nov 1970).

The K^+p phase-shift analysis solutions below 1.0 GeV/c can be classified into two groups, the ones with a negative S-wave in this whole energy range and those in which the S-wave is positive above 0.5 GeV/c. An analysis is made of this low-energy region using the boundary condition model in order to distinguish between the two possibilities and to study some of the features of these solutions, such as the possible zero in the phase shift. (L.B.S.)

7673 MODEL FOR K^-p, K^+p BACKWARD ELASTIC SCATTERINGS AT HIGH ENERGIES. Hadjioannou, F. T.; Papargyropoulos, P. (Univ. of Athens). Lett. Nuovo Cim.; 4: 924-6 (14 Nov 1970).

The K^-p and K^+p elastic backward scatterings are studied in the E_2-pole exchange model. Predictions of the model for asymptotic cross sections and polarizations are examined. (L.B.S.)

7674 ANGULAR STRUCTURE OF πN VENEZIANO MODELS. Garcia, A.; Masperi, L. (Comision Nacional de Energia Atomica, Bariloche, Argentina. Univ. Nacional de Cuyo, Bariloche, Argentina). Lett. Nuovo Cim.; 4: 929-32(14 Nov 1970).

It is investigated whether a model for πN charge-exchange scattering with Veneziano terms can reproduce the observed angular distributions as a function of energy. It is shown that, though a model can be built that fits the magnitude of forward and backward peaks as well as the widths of the most important low-lying resonances, no reasonable Veneziano model can account for the measured angular structure even relaxing some of these requirements. In particular, it is proved that the background terms are not responsible for the filling-up of the dips predicted by the Regge terms, when an imaginary part is allowed on baryon trajectories. (L.B.S.)

7675 DIRECT-CHANNEL FERMION REGGE POLES. Sakmar, I. A. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim.; 70A: 137-57(21 Nov 1970).

The assumptions made in the identification of direct-channel Regge-pole terms with the resonance amplitude are examined. The numerator function as well as the denominator are expanded without assuming the smallness of the imaginary part of α. It is shown that in the calculation of Im α the assumptions may not always be satisfied. The differential cross sections at typical resonances are calculated taking into account the contributions of the parity-reflected states and daughters. (auth)

7676 SELF-CONSISTENT CALCULATION OF THE ROPER-RESONANCE REGGE TRAJECTORY IN THE $\epsilon N \to \epsilon N$ CHANNEL. Rotsstein, A. N. (Clarkson Coll. of Tech., Potsdam, N. Y.). Nuovo Cim.; 70A: 158-64(21 Nov 1970).

Using Roper-resonance exchange (mass $\approx$ 1470 MeV) in the Born approximation plus a pole term as input forces, the ND^{-1} integral equations are solved numerically by means of matrix inversion for the single channel $\epsilon N \to \epsilon N$ in the $J^P = \frac{1}{2}^+$, $T = \frac{1}{2}$ state. The ϵ-meson is an S-wave 2π resonance ($J^P = 0^+$, $T = 0$) at a mass $\approx$700 MeV, while the Roper resonance is regarded as a bound ϵN state. Self-consistent values for the Roper-resonance mass and coupling constant are obtained. When continued to non-integral values of the orbital angular momentum, the calculation yields a Regge trajectory for the Roper resonance which is in very good agreement with the one deduced experimentally. (auth)

7677 METHOD TO TREAT SYSTEMATIC ERRORS ON EXPERIMENTAL DATA IN THEORETICAL FITS. Ferrari, E. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Violini, G. Lett. Nuovo Cim.; 4: 1015-22(28 Nov 1970).

The problem of the reliability of a theoretical fit, based on a certain model, to a given set of experimental data is re-examined. A new type of fit (theta fit) is proposed, which, instead of introducing additional parameters in the theoretical model, introduces such parameters in the experiment by taking seriously into account the possible occurrence of systematic errors. The theta formalism is applied to forward πN scattering. (L.B.S.)

7678 NUCLEON AND HYPERON STRUCTURE. MacGregor, M. H. (Univ. of California, Livermore). Lett. Nuovo Cim.; 4: 1043-9(28 Nov 1970).

The nucleon is viewed as a composite structure made up of three subunits, where the basic nucleon state is the spinor S, which contains three masses μ in a rotating configuration. The resonant structure 3μ appears as a basic entity not only for the nucleon, but also for the meson resonances. The systematics of hyperon resonances are studied in this model; rotational levels are presented for the Λ and Σ. (L.B.S.)

Strong (Baryon No. ≥ 2)

7679 (CONF-690608-, pp 167-87) NUCLEON REACTIONS. Lillethun, E. (Bergen Univ. (Norway)).

Nucleon reactions are discussed from the point of view of quark production; antideuteron production; notation; elastic p-p scattering; inelastic N-N scattering; particle production; nucleon-nucleus total cross-sections; and p-d and d-d collisions. (Sweden)

7680 (JINR-P2-4917) RELATIVISTIC PHASE-SPACE VOLUMES FOR THE ANGULAR πN CORRELATIONS IN THE REACTION $N + N \to N + N + \pi$. Suslenko, V. C. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 27p. (In Russian). Dep. NTIS (U.S. Sales Only).

The relativistic expressions for the angular πN correlation phase-space volumes for the final state of the reaction $N + N \to N + N + \pi$ were derived for a number of reference systems. These expressions are necessary to extract from experimental correlation data information relating to the square matrix element as a function of all independent invariants describing this reaction. In connection with this problem the necessary requirements to the experimental procedure are discussed. (auth)

7681 (JINR-P4-5000) CALCULATION OF THE nd SCATTERING LENGTH WITH REALISTIC POTENTIALS. Belyaev, V. B.; Wrzecionko, J.; Zubarev, A. L. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

A system of one-dimensional Faddeev equations was obtained for the problem of nd scattering at zero energy using the separable representation of two-particle t-matrix. The calculation was performed for two realistic potentials. The obtained results are compared with experiment. (auth)

7682 (NP-18551) THE VELOCITY WEIGHT FUNCTION $F(\lambda)$ OF THE THERMODYNAMICAL MODEL AND THE MULTI-REGGE MODEL. Ranft, G.; Ranft, J. (Leipzig Univ. (East Germany)). Apr 1970. 9p. Dep. NTIS (U.S. Sales Only).

Using the multi-Regge model the velocity weight function $U(\lambda)$ which approximately agrees with the empirically determined function $F(\lambda)$ of the thermodynamical is calculated. Negatively charged particle spectra are represented well at 19.2 GeV/c. The weak energy dependence of $U(\lambda)$ as compared to the energy independence of $F(\lambda)$ changes the predictions of particle yields at higher primary momenta p_0. (auth)

7683 (RLO-1388-583) SCALING BEHAVIOR IN $pp \to \pi +$ ANYTHING AT HIGH ENERGY. Bali, N. F.; Brown, Lowell, S.; Peccei, R. D.; Pignotti, A. (Washington Univ., Seattle. Dept. of Physics). [1970]. 14p. Dep. NTIS.

Evidence is presented that the inclusive reaction $p + p \to \pi +$ anything approaches a scaling limit at accelerator energies. (auth)

7684 (RLO-1388-585) ASYMPTOTIC SINGLE PARTICLE DISTRIBUTIONS IN THE MULTIPERIPHERAL MODEL. Bali, N. F.; Pignotti, A.; Steele, David (Washington Univ., Seattle. Dept. of Physics). Jun 1970. 27p. Dep. NTIS.

The conjectures of Feynman and Benecke, Chou, Yang and Yen on the high energy limit of single particle distributions are studied in the framework of the multiperipheral model. It is found that classes of multiperipheral diagrams seem to give limiting single particle distributions; pionization is present and is responsible for the logarithmic growth of the multiplicity with the energy. (auth)

7685 (RLO-1388-587) SCALING AND THE ANGULAR DISTRIBUTION OF COSMIC-RAY EVENTS. Bali, N. F.; Brown, Lowell S.; Peccei, R. D.; Pignotti, A. (Washington Univ., Seattle. Dept. of Physics). Jul 1970. 12p. Dep. NTIS.

The nature of the angular distribution of inclusive reactions that follow from the scaling hypothesis is discussed and the prediction for the reaction $p + p \to \pi +$ anything at 250 GeV/c is compared with a new cosmic ray experiment. (auth)

7686 ELASTIC SCATTERING OF PIONS ON ^{4}He AT SMALL-MOMENTUM TRANSFER. Baier, H.; Samaranayake, K. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys.; B24: 273-84(1970).

Using Glauber multiple-scattering theory, the spin effects on elastic π^--^{4}He scattering at small-momentum transfer are investigated in the region $0.826 \leq k \leq 2.01$ GeV/c pion lab momentum. Spin effects are shown to be negligible even at 0.826 Gev/c where the spin-flip part of the pion-nucleon amplitude is found to be relatively maximal. The use of an "effective" pion-nucleon amplitude is shown to be a good approximation for scattering at small-momentum transfer, thus facilitating the investigation of nuclear-correlation effects with π-^{4}He scattering experiments. (auth)

7687 PION PRODUCTION AND THE TWO-NUCLEON INTERACTION. Zollman, Dean (Univ. of Maryland, College Park). Phys. Rev., C; 2: 2128-34(Dec 1970).

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The distorted-wave Born approximation, justified in a previous study, is applied to π^0 production in proton–proton collisions. The production amplitude is studied as a function of the phenomenological two-nucleon potential used to describe the proton–proton interaction. For selected possible experiments it is shown that the pion-production amplitude depends on which phenomenological potential is used to describe the two-nucleon interaction. (auth)

7688 ON ρ-MESON PRODUCTION IN COLLISIONS OF HIGH ENERGY PIONS WITH NUCLEI. Babaev, Z. R.; Balashov, V. V.; Korenman, G. Ya.; Korotkikh, V. L.; Teku, B. (Inst. of High Energy, Moscow). Yadern. Fiz.; 12: 308-10(Aug 1970). (In Russian).

Coherent and noncoherent processes (π^-, ρ^-) and (π^-, ρ^0) on nuclei from A = 20 up to A = 208 at the incident particle energy of dozens of GeV are considered in framework of the Glauber theory. The coherent process appears to be strongly suppressed. The A dependence of the noncoherent cross section and its sensitivity to the ρN-interaction cross section is studied. (auth)

7689 INELASTIC SCREENING IN HIGH-ENERGY PION-DEUTERON SCATTERING. Gurvits, S. A.; Marinov, M. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 12: 414-16(Aug 1970). (In Russian).

By means of the Gribov theory and with experimental data on inelastic π^-p interactions it is shown that the nuclear screening in π^-d scattering at 16 GeV with account of the inelastic channels is about 50% higher than the Glauber result. With the energy rise up to 65 GeV (the Serpukhov limit) the inelastic screening may be expected to decrease. (auth)

7690 MANY-BARYON RESONANCES. Kondratyuk, L. A.; Shapiro, I. S. Yadern. Fiz.; 12: 401-13(Aug 1970). (In Russian).

A quasinuclear model of many-baryon resonances, resulting from the potential interaction of Δ isobar with nucleons, is formulated. The ΔN interaction, the decay modes and methods of production of two- and three-baryon nuclei-resonances containing Δ isobar are considered. The experimental data on two-baryon resonances with isospin T = 1 are analyzed. (auth)

7691 COUPLED-CHANNEL EFFECTIVE-RANGE ANALYSIS OF LOW-ENERGY HYPERON–NUCLEON SCATTERING. Monga, S. K.; Bhasin, V. S. (Univ. of Delhi). Nuovo Cim.; 70A: 276-84(21 Nov 1970).

The problem of hyperon–nucleon scattering at low energies is studied by setting up a coupled-channel Schrödinger equation using separable potentials. The effect of the coupled elastic Σ-N channel as well as Λ-Σ conversion on the triplet effective-range parameters for Λ-N scattering is found to be significant. The overall effect is observed to be repulsive in nature in so far as it weakens the effective Λ-N force so as to restore the original parameters in the single-channel case. It is found that a much stronger Σ-N strength parameter, which admits of a T = ½ bound state, is necessary to reproduce the observed $^3S_1$ resonance in Λ-N scattering at about 3 MeV below Σ-N threshold. In the absence of a Σ-N bound state, which seems to be in agreement with experimental data, a much stronger "mixing" parameter (responsible for Λ-Σ conversion) would be required to reproduce this resonance. (auth)

7692 ISN'T IT TIME TO CALCULATE THE NUCLEON–NUCLEON FORCE? Brown, G. E. Comments Nucl. Particle Phys.; 4: 140-6(Jul-Aug 1970).

A review of information leading to the calculation of the nucleon–nucleon force is given. It is pointed out that the one-boson exchange models are conceptually inadequate and that the extensive knowledge of the pion-nucleon scattering should be included in the problem. (J.F.P.)

Particle Invariance Principles and Symmetries

General

7693 GENERAL FORMULA TO DERIVE BRANCHING RULES. van Daele, A. (Univ. of Leuven, Belg.). J. Math. Phys. (N. Y.); 11: 3275-82(Nov 1970).

An irreducible representation of a semisimple Lie algebra L is considered. When restricted to a semisimple subalgebra K of L, this representation can be reduced with respect to K. A general formula is derived for the multiplicity of a certain irreducible representation of K, which occurs in it. The result is an extension of Kostant's formula for the multiplicity of a weight, where the subalgebra K is the Cartan subalgebra of L. Using Kostant's formula, a set of equations, containing the required multiplicity is written, completely analogous with the usual formula involving the characters. These equations are written using some properties of the partition function (used in Kostant's formula) and of the Weyl groups. Finally they are solved with the help of an "orthogonality property." The applicability is illustrated by working out two nontrivial examples. (auth)

7694 MIXED-BASIS D FUNCTIONS AND CLEBSCH–GORDAN COEFFICIENTS OF NONCOMPACT GROUPS. Klink, William H. (Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.); 11: 3210-18(Nov 1970).

Mixed-basis D functions are introduced as a tool for deriving Clebsch–Gordan coefficients of induced representations of semisimple groups. The Clebsch–Gordan coefficients of SU(1,1) and SL(2,C) are computed as examples. (auth)

7695 COMPLETE SETS OF FUNCTIONS ON HOMOGENEOUS SPACES WITH COMPACT STABILIZERS. Anderson, Robert Leonard; Wolf, Kurt Bernardo (Inst. of Theoretical Physics, Goteborg). J. Math. Phys. (N. Y.); 11: 3176-83(Nov 1970).

The problem of determining a complete set of generalized functions for a wide class of homogeneous spaces with compact stabilizers is formulated and solved. This allows one to say precisely what unitary irreducible representations can be realized on a given homogeneous space. The techniques are applied to the n-dimensional orthogonal and unitary groups. (auth)

7696 CALCULATION OF THE INNER MULTIPLICITY OF WEIGHTS BY MEANS OF THE BRANCHING-LAW METHOD AND BY RACAH'S RECURRENCE RELATION. Wong, M. K. F. (Fairfield Univ., Conn.); Gruber, B. J. Math. Phys. (N. Y.); 11: 3187-92(Nov 1970).

The validity of the branching law method suggested in a previous paper for the calculation of the inner multiplicity of weights in an irreducible representation of a classical group is discussed in detail. It is found that the method works for all the irreducible representations of SU(n) and SO(2n + 1), but that in the case of SO(2n) and Sp(2n) the method does not always give complete solutions except in some simple cases. It is then suggested that Racah's recurrence relation be used in these cases so that complete solutions may be obtained. It is also noted that Racah's recurrence relation alone is sufficient to obtain the inner multiplicity of all weights. This fact is utilized in the calculation of inner multiplicities in another paper. The method suggested is illustrated through the calculation of some typical examples of the inner multiplicity of weights in the two classical groups SO(2n) and Sp(2n). (auth)

7697 REDUCTION OF TENSOR REPRESENTATIONS OF THE ROTATION GROUP. Caudrey, P. J. (Univ. of Manchester, Eng.). Nucl. Phys.; B24: 339-57(1970).

An nth rank tensor in Minkowski four-space realises a reducible representation of the little group of rotations which leave a given time-like vector invariant. A method of extracting and classifying the parts of the tensor which realise irreducible representations is given. It also shows how the original tensor can be reconstructed if the parts are known. The same program is carried out for the case when the tensor also has one Dirac-type spinor index. Finally an indication is given of how this work may be applied to the problem of parametrising vertex functions when the particles involved do not lie on the mass-shell. (auth)

7698 ON THE CP-NONINVARIANT EQUATIONS FOR THE PARTICLE WITH ZERO MASS AND SPIN s = ½. Fushchich, V. I.; Grishchenko, A. L. (Inst. of Mathematics, Kiev). Lett. Nuovo Cim.; 4: 927-8(14 Nov 1970).

It was previously shown that for particles with zero mass and spin s = ½ there are three types of two-component equations (or one four-component equation with three different subsidiary conditions) which differ from one another by P, T, and C properties. Two relativistic invariant equations with the subsidiary condition are given. (L.B.S.)

Applications (Electromagnetic and Weak)

Refer also to abstract 7609.

7699 REALIZATION OF THE LIE GROUP G(0,1) BY THE FUNCTION OF LANDAU LEVELS. Yanagawa, S.; Moriya, T. (Tokyo Univ.). J. Math. Phys. (N. Y.); 11: 3244(Nov 1970).

The irreducible basis of the Lie group G(0,1) is obtained in connection with the quantum physical problem: a motion of a free electron in a magnetic field. The differential operators are shown to be the infinitesimal operators defined by Brown. (auth)

Applications (Strong)

Refer also to abstract 7728.

7700 BROKEN SCALE INVARIANCE. Carruthers, P. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., D.; 2: 2265-75(15 Nov 1970).

The implications of approximate scale invariance for particle masses and the dynamics of the low-lying scalar and pseudoscalar mesons are studied. Assuming that the form factor $\theta(t)$ (the trace of the energy-momentum tensor) obeys an unsubtracted dispersion relation, formulas of the Goldberger–Treiman type for hadron masses may be derived if a set of scalar mesons dominates the dispersion relation. The dependence of particle masses on the coupling strength and dimension of scale-breaking operators is studied. In addition to the scale-breaking operator u which breaks chiral symmetry, it seems necessary to introduce a scale-breaking $SU_3 \times SU_3$ singlet δ, as advocated by Wilson. The absence of δ would contradict the analysis of meson–baryon scattering lengths by von Hippel and Kim, would make the large mass of η' and the baryons difficult to understand, and would require the operator u to have a dimension −2 or mixed. At present, the evidence for δ is not completely compelling, however. In the absence of all scale breaking, two types of theories are distinguished. In the first, all masses vanish in the limit of scale invariance and the vacuum is normal under scale transformations. This is the situation envisioned in most previous research. The second alternative is that of spontaneous breakdown of scale invariance, in which case the vacuum is degenerate and most particles have masses. The latter case is especially interesting in that it requires the existence of a massless "dilaton" and further permits other masses to be not so inaccessible to extrapolations from the real world. Lagrangian models of spinless mesons are investigated to understand the interplay of scale and $SU_3 \times SU_3$ transformations. Working in the limit of $SU_3 \times SU_3$ symmetry, the scale breaking is due to the trilinear interactions. Two linear models are considered in which there are (a) 18 meson fields belonging to $(3,\bar{3}) + (\bar{3},3)$ and (b) 20 meson fields, with two extra mesons S and P belonging to (1,1) in addition to the 18 of case (a). The scale-invariant part of the Lagrangian is found to be $U_3 \times U_3$ invariant, so that the trilinear coupling δ breaks F_8^8 as well as scale. It is speculated that the real world is $U_3 \times U_3$ invariant in the scale-invariant limit (although there exist meson models in which F_8^8 does not even exist). Spontaneous breakdown is considered for cases in which the ninth scalar (σ_0) and the extra scalar (S) have nonvanishing vacuum expectation values. In the 18-meson model, spontaneous breakdown is permitted in the scale-invariant limit only when the quartic couplings have a relation prohibiting $\langle\sigma_0\rangle \neq 0$ in the presence of the scale-breaking term δ. The 20-meson model allows spontaneous scale breaking which survives when explicit scale breaking is introduced. In the latter model, the "dilaton" is a mixture of the S and σ_0 meson. The most interesting qualitative feature of the "spontaneous-breakdown" solutions is that even the canonical dimension of an operator can be somewhat ambiguous. In particular, an operator having a given dimension appropriate to a normal ground state may have different (usually several) dimensions under scale transformations appropriate to the physical ground state. (auth)

7701 DYNAMICAL APPROACH TO HIGHER SYMMETRIES. Banerjee, H. (Saha Inst. of Nuclear Physics, Calcutta); Dutta-Roy, B. Phys. Rev., D; 2: 2414-21(15 Nov 1970).

It is shown that the family of sum rules recently proposed provides a very convenient framework for the realization of higher-symmetry relations among the trilinear hadron couplings. These sum rules are derived assuming (i) unsubtracted dispersion relations for the forward as well as the backward elastic hadronic scattering amplitudes corresponding to t-channel isospin and G-parity $I^G = 1^+$, and (ii) ρ dominance in the $I^G = 1^+$ channel. The remarkable feature of the sum rule is that for the scattering of hadrons of intrinsic parities η_1 and η_2, contributions from states with parity $\eta_1\eta_2$ are suppressed (for meson-meson scattering they are entirely absent). Therefore, it is argued that the sum rules for meson-meson and meson-baryon scattering considered here will be very well saturated by the states belonging to the SU(6) 35-plet of negative-parity mesons and the 56-plet of positive-parity baryons, respectively. The consistency of this principle of saturation may be easily checked if one further assumes the universality of ρ-meson coupling to hadrons. To substantiate the validity of the last assumption, it is verified that its predictions are in excellent agreement with the values of the ρNN and ρKK coupling constants obtained from the sum rules. The hypothesis of universal ρ coupling leads to relations among the trilinear meson couplings which may be identified as the "broken"-SU(6) predictions. In the meson-baryon sector, assuming SU(3) symmetry, the SU(6) results are obtained in the static limit $m\rho/M_B \to 0$, where m_ρ and M_B are the ρ-meson and baryon masses, respectively. It is emphasized that, in contrast with similar derivations based on other sum rules, the present derivation is relatively free from ambiguities arising from arbitrary and sometimes untenable saturation assumptions. (auth)

7702 BROKEN SU(3) x SU(3) SYMMETRY. Kuo, T. K. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 2: 2439-43(15 Nov 1970).

The meaning of a proposed unitary transformation which exhibits an inherent ambiguity of the broken SU(3) × SU(3) symmetry is discussed in detail. It is suggested that invariance under this transformation be imposed upon the Hamiltonian of the hadrons. A model consistent with this requirement is proposed. Some interesting consequences of such a model are also discussed. (auth)

7703 SYMMETRY BREAKING UNDER $U_3 \times U_3$. Lai, C. S. (Univ. of Prince Edward Island, Charlottetown); Lo, S. Y. Lett. Nuovo Cim.; 4: 1037-42(28 Nov 1970).

The Gell–Mann model for chiral $U_3 \times U_3$ symmetry breaking is considered. Two models are studied where the unphysical mesons η_8 and η_0 are eigenstates of the pseudoscalar densities $P_8(x)$ and $P_0(x)$, and where they are eigenstates of the axial-vector currents $A_8(x)$ and $A_{0\mu}(x)$. It is found that in the first model the symmetry-breaking parameter is equal, i.e., c = b = −1.00. The second model yields the relation $\sqrt{2}(b + c) = bc$. (L.B.S.)

Field Theories

General

Refer also to abstract 7695.

7704 INVERSION OF NOETHER'S THEOREM IN THE LAGRANGIAN FORMALISM. II. CLASSICAL FIELD THEORY. Candotti, E. (Istituto Nazionale di Fisica Nucleare, Naples); Palmieri, C.; Vitale, B. Nuovo Cim.; 70A: 233-46(21 Nov 1970).

Both the "direct" and the "inverse" Noether's theorems are generalized to allow for infinitesimal transformations that add to the action functional an integral over a 4-divergence and an integral over a function vanishing "on the orbit" (Noether transformations). It is then shown that: i) to every Noether transformation there corresponds a "weak" continuity equation and a family of Nother transformations (Noether family) defining the same continuity equation; ii) every Noether family contains an invariance transformation; iii) to every "weak" continuity equation there corresponds a Noether family; iv) every Noether family contains a subset of Noether transformations equivalent to a 4-divergence translation of the Lagrangian density. (auth)

Quantum Field Theory

Refer also to abstracts 7592, 7628, 7695, 7742, 7743, and 7752.

7705 (IC–70/106) RENORMALIZATION CONSTANTS AND INTER-RELATION OF FUNDAMENTAL FORCES. Salam, Abdus (International Centre for Theoretical Physics, Trieste (Italy)). Sep 1970. 27p. (CONF-700806–41). Dep. CFSTI (U. S. Sales Only).

From 15th International Conference on High Energy Physics, Kiev, USSR.

The problem of ambiguities in finite computations of renormalization constants for nonpolynomial Lagrangians in field theory is considered. The procedure is suggested to obtain from experiment the dependence of the normalization constants on physical coupling constants and to formulate a "maximum analyticity principle" based on the analytic dependence of the Lagrangians on the variable $\kappa\phi$, where ϕ is the field and κ is the minor coupling constant. Some qualitative and preliminary conclusions are made concerning the magnitudes of the finite renormalization constants within the context of this procedure. The strong chiral Lagrangians, weak Lagrangians with the Fermi constants, and Einstein's gravitational Lagrangian with the newtonian constant are considered. A review of the present status of the ambiguity problem and the procedure for the computation of renormalization constants are given in the Appendix. (L.B.S.)

7706 (NYO–3829-56) SCALE-INVARIANCE AND SHORT DISTANCE BEHAVIOR IN A SIMPLE MODEL. Schroer, B. (Pittsburgh Univ., Pa. Dept. of Physics). Aug 1970. Contract AT(30-1)-3829. 17p. (CONF-700710–2). Dep. NTIS.

From Conference on Special Topics in Quantum Field Theory, St. Louis, Mo.

XUM

Two soluble two-dimensional models are considered for the relation between the scaling group of the zero-mass limit of a massive theory and the short-distance behavior of vacuum expectation values. These models are the derivative coupling model and the Thirring model. (J.F.P.)

7707 SIMPLE LOCALLY-GAUGE-INVARIANT LAGRANGIAN MODEL. Beckerman, M.; Wojtaszek, J. H. (Univ. of Miami, Coral Gables, Fla.). Nucl. Phys.; B24: 441-4(1970).

A method is presented for the construction of a locally-gauge-invariant chiral SU(3) ⊗ SU(3) Lagrangian containing only pseudoscalar mesons and baryons. It is found that the gauge transformations must satisfy first-order differential equations involving the psuedoscalar-meson coupling matrix. The relation is then found between this model, the usual Yang-Mills approach, and the pseudoscalar-meson vector and axial-vector currents appearing in some Lagrangian models for Sugawara's field theory of currents. (auth)

7708 NONLOCAL INFINITE-COMPONENT WAVE EQUATION WITH A PHYSICAL MASS SPECTRUM. Casalbuoni, R. (Univ., Padua); Longhi, G. Nuovo Cim.; 70A: 329-43(1 Dec 1970).

An infinite-component wave equation is studied, which involves the nonlocal operator W/p^2, where W is the Pauli-Lubansky invariant. A method of quantization is proposed, which leads to a local commutation relation for the field. In particular a wave equation with a linear mass spectrum and without unphysical solutions is considered. A suitable choice of the Lagrangian gives rise to an algebra of conserved currents free of Schwinger terms in the time-time commutators. (auth)

7709 REGULARIZATION OF QUANTUM ELECTRODYNAMICS THROUGH NONPOLYNOMIAL LAGRANGIANS. Budini, P. (International Centre for Theoretical Physics, Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy); Calucci, G. Nuovo Cim.; 70A: 419-39(1 Dec 1970).

A model for regularizing quantum electrodynamics through a nonpolynomial Lagrangian describing the interaction of the electron field with an auxiliary field is given. A gauge-invariant Lagrangian density is obtained. This kind of regularization avoids the difficulties connected with an indefinite metric. Renormalization of quantum electrodynamics is performed for irreducible diagrams. In the hypothesis that this kind of regularization is the physical basis for elimination of divergences in quantum electrodynamics, the physical implications are discussed. In particular, the limits of validity of quantum electrodynamics are discussed in terms of the coupling constant between the electron and the regularizing field. It is found that the present limits of validity of quantum electrodynamics imply for this coupling constant an upper limit larger than the weak-coupling constant. The possibility of regularization through weak interactions is discussed. In this model, for every reasonable coupling constant, the electromagnetic self-mass of the electron is only a fraction of the total mass. (auth)

7710 CALCULATION OF COLLIDING REGGE TRAJECTORIES WITH THE BETHE–SALPETER EQUATION. Ladanyi, K. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 70A: 405-18(1 Dec 1970).

Representative examples of colliding Regge trajectories are computed by solving the Bethe-Salpeter equation of scalar particles in the ladder approximation. Particular attention is paid to the level mixing effects of the mass difference leading to complex-conjugate pairs of trajectories. The calculations include the imaginary part of the total energy at real values of the angular momenta. The numerical procedure is based on a generalized least-squares method. (auth)

7711 PROPER VIBRATION OF THE SPACE. Kulhanek, J. (Univ. of Windsor, Ont.). J. Math. Phys. (N. Y.); 11: 3195-9(Nov 1970).

The proper vibrations of homogeneous and isotropic space are examined on the basis of the equations of the de Broglie wave field (field equations). The time-dependent part of the wavefunction, which is a solution of the Klein–Gordon equation, satisfies the differential equation which coincides with the differential equation derived from field equations for the time-dependent part of the Robertson–Walker metric. (auth)

7712 EQUATIONS OF THE DE BROGLIE WAVE FIELD AND THEIR RELATION TO RIEMANN'S CURVATURE TENSOR. Kulhanek, J. (Univ. of Windsor, Ont.). J. Math. Phys. (N. Y.); 11: 3199-3200(Nov 1970).

The equations of the de Broglie wave field (field equations) under special conditions require a very particular geometry together with a specific interpretation of the curvature scalar. It is shown that the same condition turns the conservation law (which is a consequence of the field equations) into an identity and that the Rainich decomposition of Riemann's curvature tensor gives only one component. (auth)

7713 CELL MODEL FIELD THEORIES. Grimmer, Hans (Battelle Inst., Geneva). J. Math. Phys. (N. Y.); 11: 3283-95(Nov 1970).

A class of nonrelativistic, self-interacting model field theories is investigated assuming the existence of field and momentum operators that satisfy the canonical commutation relations (CCR's). The large symmetry that is assumed permits one to determine explicitly all the relevant CCR representations and Hamiltonians. For each irreducible representation there exists only one Hamiltonian, which describes no interaction. Hence every model with interaction requires a reducible CCR representation. A nontrivial S operator is expected to exist for many of these models. It is examined how close the models can come to relativistic theories. (auth)

7714 EXISTENCE OF CHARGED STATES OF THE YANG–MILLS FIELD. Loos, Hendricus G. (Douglas Advanced Research Labs., Huntington Beach, Calif. Univ. of California, Riverside). J. Math. Phys. (N. Y.); 11: 3258-74(Nov 1970).

For a tentative choice of configuration space Ω, it is proved that the Yang–Mills field, self-interacting but not coupled to other fields, has states with a nonvanishing isospin component if gauge-invariant quantization is used. This is shown by proving the existence of a solution for the elliptic boundary value problem $\nabla_\beta \nabla^\beta \xi^i(x) = 0$ on all of 3-dimensional Euclidean space, subject to the asymptotic condition $\xi^i = c^i + O(r^{-1})$, $\partial_\beta \partial^\beta \xi^i = O(r^{-4})$ as $r \to \infty$, where c^i are constants; ∇_β is the covariant derivative belonging to the spatial Yang–Mills potentials $b^i_\beta(x)$. The existence proof is a modification of Schauder's proof to an unbounded domain. Ω consists of all numerical real multiplet functions $b^i_\beta(x)$ which are of order $O(r^{-2})$ as $r \to \infty$, have $\partial_\beta b^{\beta i} = O(r^{-4})$, and satisfy certain smoothness conditions. Also, for this configuration space, the problem of existence of equivalent transverse potentials is reduced to a simpler uniqueness problem. In the classical theory, the existence of solutions ξ^i implies that the constraint equation can be satisfied for any choice of the "covariant-transverse" part of $B^{\theta\beta i}$ within a very large class, by a unique "covariant-longitudinal" part of $B^{\theta\beta i}$, if the potentials $b^i_\alpha(x)$ have the full SU(2) as holonomy group. (auth)

7715 LORENTZ GROUP AND THE SPHERE. Held, A.; Newman, E. T.; Posadas, R. (Univ. of Pittsburgh). J. Math. Phys. (N. Y.); 11: 3145-54(Nov 1970).

A direct connection between the spin and conformally weighted functions on the sphere and geometric objects in Minkowski space is established through the isomorphism of the conformal group of the sphere to the restricted Lorentz group. It is shown that with the use of these functions one can duplicate all the standard work on the representations of the Lorentz group. It is shown further that these functions can be used to obtain a generalization of the classical equations of motion in which internal degrees of freedom arise naturally. (auth)

7716 RISE AND FALL OF RELATIVISTIC TRAJECTORIES. Swift, Arthur R.; Tucker, Robin W. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 2: 2486-2500(15 Nov 1970).

The general problem of rising and falling Regge trajectories is investigated in a fully relativistic model in which an arbitrary two-particle interaction is unitarized by summing generalized ladder diagrams. The trajectories are extracted from the infinite sum by an extension of the technique previously applied to ladder diagrams in an ordinary scalar field theory. Any basic interaction which vanishes faster than any power of the momentum transfer t generates infinitely falling trajectories. A physical explanation of falling trajectories is given in terms of the scattering of infinitely composite particles where the standard single-particle-exchange interaction is modified by exponentially damped form factors. A variety of models for rising trajectories is constructed, all of which violate either the Jaffe bound on form factors or the Froissart bound on forward scattering amplitudes. If the interaction is single-particle exchange with form factors $e^{-\gamma(-t)^\beta}$, the trajectory has $\mathrm{Re}\alpha \to +\infty$ as $s \to \infty$ if $\beta \geq 1$, but is not of narrow width. Energy-dependent interactions based on Regge-pole exchange, energy-dependent coupling constants, or direct form factors yield rising trajectories, but not narrow widths. Moreover, the energy dependence must be such that the Froissart bound appears to be grossly violated. (auth)

7717 GAUGE PROBLEM IN QUANTUM FIELD THEORY, III. QUANTIZATION OF MAXWELL EQUATIONS AND WEAK LO-

XUM

CAL COMMUTATIVITY. Strocchi, F. (Istituto Nazionale di Fisica Nucleare, Pisa, Italy. Scuola Normale Superiore, Pisa, Italy). Phys. Rev., D; 2: 2334-40(15 Nov 1970).

The problem of the quantization of the Maxwell equations is analyzed in connection with the basic assumptions of quantum field theory. It is shown that it is impossible to quantize the Maxwell equations by means of a potential $A_\mu(x)$ which is a weakly local field. Thus, a result which was known for the Coulomb gauge is shown to hold in general: The quantization of the Maxwell equations requires the use of a potential $A_\mu(x)$ which is both noncovariant and nonlocal. It is shown that a weakly local and/or covariant operator $A_\mu(x)$ can be introduced only in a Hilbert space in which the vectors corresponding to physical states do not form a dense set, and therefore unphysical states must be present. The connections with the Gupta–Bleuler formulation are discussed. (auth)

7718 NONLINEAR EFFECTS IN QUANTUM ELECTRODYNAMICS. PHOTON PROPAGATION AND PHOTON SPLITTING IN AN EXTERNAL FIELD. Bialynicka-Birula, Z.; Bialynicki-Birula, I. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Phys. Rev., D; 2: 2341-5(15 Nov 1970).

The effective nonlinear Lagrangian derived by Heisenberg and Euler is used to describe the propagation of photons in slowly varying but otherwise arbitrary electromagnetic field. The group and the phase velocities for both propagation modes are calculated, and it is shown that the propagation is always causal. The photon splitting processes are also studied, and it is shown that they do not play any significant role even in very strong magnetic fields surrounding neutron stars. (auth)

7719 REGGE SLOPES AND RESIDUES FOR A SPIN-1 + SPIN-0 SYSTEM IN THE CONTENT OF O(4) SYMMETRY AND BETHE–SALPETER MODEL. Abo-Shaeer, Muhsin A. R. (Univ. of California, Santa Barbara). Phys. Rev., D; 2: 2397-2404 (15 Nov 1970).

The Bethe–Salpeter equation for a spin-1 + spin-0 system at vanishing total 4-momentum K is separated by means of the O(4) vector spherical harmonics, which are defined and discussed briefly. Perturbation expressions for the M = 1 residues near K = 0 are derived and then examined near J = 0, where it is found that only the nonsense part of the O(3) content of the M = 1 residues survives. Perturbation expressions are given also for the slopes of Regge trajectories at $s = -K^2 = 0$, the signs of the slopes are investigated for certain classes of potentials, and a sum rule satisfied by slopes of contiguous daughters is derived. (auth)

7720 TOWER EXCHANGE IN $\lambda\varphi^3$ THEORY. Hasslacher, B. (State Univ. of New York, Stony Brook); Sinclair, D. K.; Cicuta, G. M.; Sugar, R. L. Contract AT(30-1)-3668B. Phys. Rev. Lett.; 25: 1591-3(30 Nov 1970).

The asymptotic behavior of two-tower exchange with linked ends in φ^3 theory is studied using Feynman parameter techniques. A new result is presented for the asymptotic behavior of the Mandelstam graph, and it is noted that only this graph contributes for the two-tower case. The above is generalized to the N-tower case and the eikonal form is found. (auth)

7721 PROBLEM OF QUASIPOTENTIAL SMOOTHNESS IN QUANTUM FIELD THEORY MODELS. Barbashov, B. M.; Kuleshov, S. P.; Matveev, V. A.; Sissakian, A. N.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 33B: 419-21(23 Nov 1970).

An interpretation of the smooth complex quasipotential is given in the framework of the eikonal consideration of quantum field theory models. (auth)

7722 FORMULATION OF QUANTUM ELECTRODYNAMICS WITHOUT DIVERGENCES. Tyutin, I. V.; Fradkin, E. S. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 12: 417-28(Aug 1970). (In Russian).

A method is proposed to redefine Lagrangian and current operators satisfying group properties of initial classical theory. Applying to electrodynamics, this method results in finite (nonlocal) unitary gauge-invariant canonic theory. A noncanonic model of finite electrodynamics is also discussed. (auth)

7723 PRIMARY REPRESENTATIONS OF THE COMMUTATION OR ANTICOMMUTATION RELATIONS AND DEGENERACIES OF THE PHYSICAL STATES. Cordesse, A. (College de France, Paris). Lett. Nuovo Cim.; 4: 997-8(21 Nov 1970).

It is shown that the use of primary representations of commutation or anticommutation relations leads to some degeneracies of the physical systems considered. In the Fermi-field case it is briefly indicated how these degeneracies can disappear. (L.B.S.)

7724 DERIVATION OF EQUAL-TIME COMMUTATORS INVOLVING THE SYMMETRIC ENERGY-MOMENTUM TENSOR AND APPLICATIONS. Genz, H. (Univ. of California, Berkeley); Katz, J. Phys. Rev., D.; 2: 2225-41(15 Nov 1970).

The use of covariance and the Jacobi identity in the study of equal-time commutators is investigated. The most general form of the equal-time commutators compatible with covariance is used together with the Jacobi identities to derive relations between the equal-time commutators. This information is first used in deriving equal-time commutators in canonical models. For currents obeying the algebra-of-fields commutators, restrictions are obtained on Schwinger terms contained in equal-time commutators involving time derivatives of the currents. These relations show, for example, that in canonical realizations of current-field identities one needs derivative couplings of the spin-1 field. (L.B.S.)

7725 SELF-ADJOINTNESS OF THE YUKAWA$_2$ HAMILTONIAN. Glimm, James (New York Univ.); Jaffe, Arthur. Contract AF-49(638)-1719. Ann. Phys. (New York); 60: 321-83(Oct 1970).

It is proved that the Hamiltonian H(g) for the Yukawa$_2$ interaction with a spatial cutoff is self-adjoint. H(g) is defined as the limit of operators $H(g,\kappa)$ with an ultraviolet cutoff. The ultraviolet cutoff makes the mass renormalization constant $\delta m^2(g,\kappa)$ and the vacuum self-energy $E(g,\kappa)$ finite, but these constants both diverge logarithmically as $\kappa \to \infty$. The renormalization constants required by perturbation theory is chosen. As $\kappa \to \infty$, the resolvents of the self-adjoint operators $H(g,\kappa)$ converge in norm to the resolvent of the self-adjoint operator H(g). In addition H(g) has a vacuum vector. (auth)

7726 DILATATION-LIKE CURRENTS AND SCALAR MESONS. Chang, L. N. (Univ. of Chicago); Freund, P. G. O. Ann. Phys. (N. Y.); 61: 182-90(Nov 1970).

Field-current identities for scalar mesons and the divergences of dilatation-like currents are exhibited in Lagrangian field theories. A possible relation between the algebraic structure of the energy-momentum tensor and the Gell-Mann–Oakes–Renner symmetry breaking mechanism is suggested. It is shown that beyond the pieces dominated by the I = 0 scalar mesons of a nonet, the trace θ of the energy-momentum tensor must contain an extra ("tenth") piece or else $m_\rho = m_\pi$. (auth)

7727 CONCERNING THE VALIDITY OF THE SACHS–SCHWEBEL THEORY OF QUANTUM ELECTRODYNAMICS. Mann, R. A. (Univ. of Dayton, Ohio). Lett. Nuovo Cim.; 4: 911-12(14 Nov 1970).

It is argued that the Sachs–Schwebel calculation of the Lamb shift in spinor field theory of quantum electrodynamics is not valid since it ignores the magnetic-interaction contribution to the magnetic-field splitting, which is not negligible but is almost 10% of the Lamb splitting and well within the range of experimental error. (L.B.S.)

7728 CONFORMAL COVARIANCE OF FIELD EQUATIONS. Flato, Moshe; Simon, Jacques; Sternheimer, Daniel (Coll. de France, Paris). Ann. Phys. (N. Y.); 61: 78-97(Nov 1970).

A rigorous definition of conformal covariance of field equations in first and second quantized field theories is given. The general implications of these definitions as well as the necessary and sufficient conditions for Poincaré plus dilatation covariance to imply conformal covariance are then discussed. Families of existing field equations are then divided into two different series according to the relations between the conformal degree of the field and its spin. In addition, remarks are made which connect conformal behavior of field equations with theories of strong interactions. (auth)

Gravitation and General Relativity

7729 (NP-18549) BOSON FIELDS WITH THE $\lambda\phi^3$ INTERACTION IN TWO, THREE, AND FOUR DIMENSIONS. Osterwalder, Konrad (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1970. 133p. Dep. NTIS (U.S. Sales Only).

Thesis.

The $\lambda \int :\phi^3(x): h(x)\,dx$ interaction for boson fields in 2, 3, and 4 dimensional space time is considered. The function h(x) provides a space cut off. It is shown that the renormalized Hamiltonian H_{ren} exists as densely defined symmetric operator, which is not bounded from below. (auth)

7730 NEW APPROACH TO THE MOTION OF A POLE–DIPOLE PARTICLE. Newman, E. T. (Univ. of Pittsburgh); Young, Roger. J. Math. Phys. (N. Y.); 11: 3154-8(Nov 1970).

A new approach to the equations of motion of the pole–dipole particle in linearized general relativity is presented. It is based on earlier work for the monopole particle. Though the results

are not new, the novelty of the method holds out the serious hopes that the work can be extended to the full theory. (auth)

7731 STATIC AXIALLY SYMMETRIC GRAVITATIONAL FIELDS. Voorhees, B. H. (Univ. of Texas, Austin). Phys. Rev., D; 2: 2119-22(15 Nov 1970).

One of the major problems in understanding solutions of the gravitational field equations is to determine the physical meaning of the coordinates involved. In particular, for the Weyl solutions if the standard coordinate descriptions are used, then physical interpretation becomes difficult. A means of interpreting the Weyl coordinates for static axially symmetric metrics is presented which allows a reasonable physical interpretation of any given Weyl metric. (auth)

7732 ANGULAR MOMENTUM LOSS BY GRAVITATIONAL RADIATION. Campbell, William B. (Univ. of Nebraska, Lincoln). Phys. Rev., D; 2: 2123-5(15 Nov 1970).

The angular momentum flux from a confined gravitational radiator is calculated in the linear approximation using the Landau–Lifshitz energy-momentum pseudotensor. This flux can be written in a simple form involving a total angular momentum operator, in complete analogy with the electromagnetic result. A multipole expansion is used which allows the flux to be expressed for the first time to all multipole orders. (auth)

7733 STATIC CHARGED-DUST DISTRIBUTIONS IN GENERAL RELATIVITY. Misra, R. M. (Univ. of Gorakhpur, India). Phys. Rev., D; 2: 2125-7(15 Nov 1970).

The field equations of general relativity with electromagnetic stress tensor and charged incoherent matter, along with Maxwell equations in curved space, are investigated. The metric coefficients and the electromagnetic field tensor are assumed to be independent of x^0. It is then shown that, if one assumes a functional relation between g_{00} and the electrostatic potential (which is a consequence of the Bianchi identities), one can then find a solution of the coupled Einstein–Maxwell equations in terms of a solution of the Einstein equations with incoherent matter as source. (auth)

7734 GRAVITATIONAL FIELD OF A PARTICLE FALLING IN A SCHWARZSCHILD GEOMETRY ANALYZED IN TENSOR HARMONICS. Zerilli, Frank J. (Joseph Henry Labs., Princeton, N. J.). Phys. Rev., D; 2: 2141-60(15 Nov 1970).

The pulse of gravitational radiation given off when a star falls into a "black hole" near the center of our galaxy is studied. The problem of a small particle falling in a Schwarzschild background ("black hole") is considered and its spectrum in the high-frequency limit is examined. In formulating the problem it is essential to pose the correct boundary condition: gravitational radiation not only escaping to infinity but also disappearing down the hole. The problem is examined in the approximation of linear perturbations from a Schwarzschild background geometry, utilizing the decomposition into the tensor spherical harmonics given by Regge and Wheeler (1957) and by Mathews (1962). The falling particle contributes a δ-function source term (geodesic motion in the background Schwarzschild geometry) which is also decomposed into tensor harmonics, each of which "drives" the corresponding perturbation harmonic. The power spectrum radiated in infinity is given in the high-frequency approximation in terms of the traceless transverse tensor harmonics called "electric" and "magnetic" by Mathews. (auth)

7735 EFFECT OF THE EARTH'S REVOLUTION AROUND THE SUN ON THE PROPOSED GYROSCOPE TEST OF THE LENSE–THIRRING EFFECT. Barker, B. M.; O'Connell, R. F. (Louisiana State Univ., Baton Rouge). Phys. Rev. Lett.; 25: 1511-12(23 Nov 1970).

The proposed Stanford experiment (precession of the spin of a gyroscope in an earth satellite) to test the Lense–Thirring effect. It is shown that the sun also makes a contribution to the precession which must be included, particularly if one wishes to distinguish between the Einstein and Brans–Dicke theories. (auth)

7736 THEORY OF SUPERSPACE. I. STATICS. Fischer, Arthur Elliot. Princeton, N. J.; Princeton Univ. (1969). 94p. University Microfilms Order No. 70-14,203.

Thesis.

Superspace is the space of all geometries of a fixed compact 3-dimensional manifold. It is the configuration space for a dynamical theory of general relativity, i.e., the space in which the geometries of space itself evolve. A theory of superspace is introduced. The main problem is that superspace, although a topological space, does not have a manifold structure. Some geometries are more symmetric than others, and therefore do not have neighborhoods homeomorphic to neighborhoods of geometries which have no symmetries at all. Consequently, these symmetric geometries are singular points in superspace. This structure problem is resolved by the stratification theorem. Superspace is shown to be partitioned into manifolds of geometries, the strata, such that the geometries of high symmetry are completely contained in the boundary of geometries of lower symmetry. A limit of geometries of the same type must therefore be either of the same symmetry type or more symmetrical. In this way a "generalized" dynamical analysis on superspace is possible. In order to make some specific statements about the superspaces of some particular topologies, a complete determination of all topologies compatible with geometries which exhibit continuous groups of symmetries is made (superspatial topology theorem). The basic idea is that a symmetric geometry can only be supported by a "symmetric" topology. The stratum theorem shows that the homogeneous geometries are parameterized by a finite-dimensional manifold. These results are then applied to determine explicitly all finite-dimensional strata for the topologies on which such symmetric geometries can occur. (Diss. Abstr. Int., B)

7737 CLASSICAL SCATTERING OF GRAVITATIONAL WAVES BY A MASSIVE PARTICLE. Lawrence, John Keeler. Boston; Northeastern Univ. (1968). 66p. University Microfilms Order No. 69-18,558.

Thesis.

The classical scattering of gravitational waves by a massive particle is considered to investigate the existence of a low-energy threshold theorem for gravitational scattering. In particular, the low-frequency limit of the classical cross section is compared with the quantum mechanical perturbation theory result of Cooke. A simple dimensional argument shows that, in the low-frequency limit, the first Born approximation result using only the first order contribution of the interaction strength GM is the rigorous result unless other parameters describing the interior structure of the particle enter at all frequencies. The calculation may be linearized in the wave disturbances of the metric without loss of rigor in the cross section. A theory of scattering is developed in the nonlinear, coordinate covariant theory of general relativity, and a cross section is given which is invariant both with respect to coordinate changes in the field of the target particle and with respect to gauge changes in the radiation. It is shown that the Einstein equations of the system can be reduced to Schrödinger-like wave equations on the flat metric with all effects of the target included in a static effective potential. The proper degree of regularity of the potential is guaranteed by the inclusion of a static interior furnishing for the particle which is larger than its Schwarzschild radius. The effect of the recoil of the target matter is of at least second order in G. The scattering cross section is calculated in first Born approximation to first order in GM. In the low frequency limit the interior structure of the particle is suppressed, and a result is obtained which is identical to the low energy limit of the quantum perturbation theory result of Cooke. The second Born term using the linearized particle field exists and vanishes in the low frequency limit. When higher orders of GM are included in the first Born term, however, interior structure parameters enter into the result even at zero frequency, thus precluding a rigorous threshold theorem. The fundamental reason for this appears to be the nonlinear nature of the gravitational theory. (Diss. Abstr. Int., B)

7738 SUPERPROPAGATOR FOR GRAVITONS. Delbourgo, R.; Hunt, A. P. (Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 4: 1010-14(28 Nov 1970).

It was previously suggested that all ultraviolet infinities occurring in renormalizable theories of particle physics disappear by including gravitational effects. Explicit calculations of the graviton superpropagator in both x-space and p-space for one coordinate system are given. It is shown from leading-order behavior considerations that infinities can be expected to be suppressed, applying Dyson's usual power-counting method for estimating divergences. (L.B.S.)

7739 CONSEQUENCES OF THE TRANSVERSALITY OF THE GRAVITON EMISSION AMPLITUDE. Kobsarev, I. Yu.; Zakharov, V. I. (Inst. of Theoretical and Experimental Physics, Moscow). Ann. Phys. (New York); 60: 448-63(Oct 1970).

The divergence condition is used to reconstruct the amplitude for the soft graviton emission in n-particle collisions up to terms linear in graviton momentum q, taking into account terms depending on the spins of the colliding particles. It is shown that the vertex parts for graviton emission are determined uniquely up to the same order in q. In particular, it is proved that no gravitational dipole moments can appear, and it is shown that the existence of dipole moments would contradict the general covariance of the gravitational interaction and the equivalence principle. The cases of colliding particles with spins 0 and $\frac{1}{2}$ and of arbitrary integer spin are considered. (auth)

7740 INTRINSIC DERIVATION OF THE ALREADY UNIFIED FIELD THEORY OF MAXWELL, EINSTEIN, AND RAINICH. Rosenbaum, M. (General Electric Co., Santa Barbara, Calif.); Luehr, C. P. Ann. Phys. (New York); 60: 384-400(Oct 1970).

A new and simpler derivation of the equation of the "already unified field theory" of Maxwell, Einstein, and Rainich is presented. The approach is based on an extension to the manifold of general relativity of the intrinsic tensor techniques described in a previous paper. (auth)

7741 SUPERCONDUCTING AND NORMAL METALS AS DETECTORS OF GRAVITATIONAL WAVES. Papini, G. (Univ. of Saskatchewan, Regina). Lett. Nuovo Cim.; 4: 1027-32(28 Nov 1970).

The theory of superconductors and normal metals in quasi-stationary gravitational fields was recently developed. The metals, when acted upon by a gravitational wave, emit electromagnetic radiation of the same frequency of the incoming gravitational wave and thus behave as devices suitable for transforming gravitons into photons. The efficiency of the transformation and the consequent possibility of detecting gravitational waves through the induced emission of electromagnetic radiation are studied. (L.B.S.)

Scattering Theory

Refer also to abstracts 7669 and 7695.

7742 (JINR-P2-5099) THREE-DIMENSIONAL COVARIANT FORMULATION OF THE THREE-BODY PROBLEM IN QUANTUM FIELD THEORY. Vinogradov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

On the basis of the three-dimensional formulation of quantum field theory the relativistic analog of the Faddeev equations for scattering amplitude are obtained. The system satisfies three-body unitarity and the correspondence principle. (auth)

7743 (JINR-P2-5101) RELATIVISTIC THREE-BODY PROBLEM IN CONFIGURATION REPRESENTATION. Vinogradov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

On the basis of the three-dimensional formulation of the quantum field theory the configuration space in the relativistic three-body problem is introduced. A finite-difference analog of the Schrödinger equations in terms of relative variables is obtained. On the basis of these equations a relativistic generalization of the Faddeev integral equations for the wave function is formulated. Difficulties caused by the integral character of the relations between the relative variables are pointed out. (auth)

7744 (NP-18543) GHOST KILLING WITH SATELLITES. Montvay, I. (Roland Eotvos Univ., Budapest (Hungary). Inst. for Theoretical Physics). Jun 1970. 8p. (ITP-278). Dep. NTIS (U. S. Sales Only).

An iterative procedure is described for the elimination of ghosts and parity partners on a finite number of daughter trajectories in the generalized Veneziano model. (auth)

7745 (RLO-1388-579) MULTIPARTICLE RELATIVISTIC K-MATRIX EQUATIONS AND UNITARITY. Dash, Jan W.; Pignotti, A. (Washington Univ., Seattle. Dept. of Physics). Mar 1970. 35p. Dep. NTIS.

An extension of the work of Baker and Blankenbecler is presented in which $2 \rightarrow 2$, $2 \rightarrow n$ and $m \rightarrow n$ particle amplitudes satisfy unitarity, including both elastic and inelastic terms. Disconnected parts of the $m \rightarrow n$ amplitudes are, however, not included. Dynamical applications of the model to the unitarization of meromorphic Born terms are briefly discussed. In particular, pole degeneracies are shown to be broken and factorization of output resonance poles is proved. (auth)

7746 (RLO-1388-590) DIVERGENT REGGE HELICITY SUMS, DISTRIBUTIONS, AND TOLLER ANGLES. Dash, Jan W. (Washington Univ., Seattle. Dept. of Physics). Aug 1970. 21p. Dep. NTIS.

Divergent infinite helicity sums appearing in complex J continuations of multiparticle unitarity equations including the Faddeev equations, and in the multi-Froissart-Gribov formalism are made convergent by regarding the amplitude as a distribution in the Toller azimuthal angles conjugate to the helicities. Some aspects of dynamical calculations using this formalism are discussed. (auth)

7747 (RLO-1388-591) MULTIPERIPHERAL NON-FACTORIZATION, SIGNATURE, AND TOLLER ANGLE VARIABLE CUTS. Dash, Jan W. (Washington Univ., Seattle. Dept. of Physics). Aug 1970. 30p. Dep. NTIS.

It is shown that the assumption of a multi-Froissart-Gribov definition of signature for multiparticle amplitudes coupled with the existence of discontinuities of internal Regge residue coupling functions in Toller angle variables in general gives rise to a non-factorizable expression for the asymptotic behavior of the full amplitude, even when the signatured amplitudes factorize. Factorizability occurs only in certain exceptional cases, including strict exchange degeneracy. The formalism can be cast into a two-vector form, however, which does factorize in a matrix sense. Chew-Goldberger-Low type equations thus become 2×2 matrix equations in general. (auth)

7748 K-MATRIX, ABSORPTION CORRECTIONS, AND REGGE POLES. Schonfelder, J. L.; Riordan, F. (Univ. of Birmingham, Eng.). Nuovo Cim.; 70A: 373-83(1 Dec 1970).

By suitably defining the K-matrix with only the two-particle cuts removed, its cut structure at high energy is investigated and it is shown that is is not unreasonable to approximate this amplitude by single Regge-pole exchange. It is also shown that the integral equation relating this K-matrix to the full T-matrix can be solved approximately at high energies giving a modified form of the absorption model. Thus a theoretical framework is found in which it is reasonable to apply absorptionlike corrections to a Regge-pole exchange amplitude. (auth)

7749 REGGE TRAJECTORIES FOR THE INVERSE SQUARE POTENTIAL. Ferreira, Erasmo (Pontificia Univ. Catolica, Rio de Janeiro); Sesma, Javier. J. Math. Phys. (N. Y.); 11: 3245-50(Nov 1970).

The analytic properties of the S function in the complex annular momentum plane for regular potentials with inverse square tails are discussed. Special attention is given to the determination of the poles of S in the limits of low and high energies. Two soluble examples are considered in detail. (auth)

7750 DIAGONALIZATION OF THE NATURAL PARITY IN THE MULTIPERIPHERAL EQUATIONS. Ciafaloni, Marcello (Univ. of California, Berkeley); Yesian, Harry J. Phys. Rev., D; 2: 2500-8(15 Nov 1970).

The crossed partial-wave analysis of the multiperipheral equations is extended to include the natural-parity quantum number. At nonvanishing momentum transfer, a constraint imposed by reflection symmetry on the two-Reggeon–particle vertex function is shown to diagonalize a discrete index κ, which therefore assumes the meaning of a parity index. At vanishing momentum transfer, the result is a selection rule for the vertex function between input Regge poles and an output Regge pole of Toller quantum number $M = 0$. It turns out that, to leading order in the asymptotic expansion in the subenergies, the product of the three natural parities at the vertex has to be positive. The $t = 0$ limit and some possible implications of this selection rule are also discussed. (auth)

7751 NEW DERIVATION AND GENERALIZATION OF A MODIFIED EIKONAL FORMULA. Harrington, David R. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., D; 2: 2512-13(15 Nov 1970).

An alternative derivation is presented for a modified eikonal formula for potential scattering recently obtained by Lévy and Sucher. Generalizations corresponding to trajectories formed from an arbitrary number of straight-line segments are also derived. (auth)

7752 NONPLANAR GRAPHS AND THE BETHE-SALPETER EQUATION. Levine, M. J. (Carnegie-Mellon Univ., Pittsburgh); Wright, Jon. Phys. Rev., D; 2: 2509-10(15 Nov 1970).

Previous calculations of the Bethe–Salpeter equations are extended to include a simple nonplanar graph in the kernel of the equation. (auth)

7753 MULTIPERIPHERAL INTEGRAL EQUATION FOR FORWARD SCATTERING AND ITS PROPERTIES. Pinsky, Stephen (Weizmann Inst. of Science, Rehovoth, Israel); Weisberger, William I. Phys. Rev., D; 2: 2365-73(15 Nov 1970).

A multiperipheral integral equation for forward scattering is studied. From positivity of the kernel it is shown that the leading asymptotic behavior of the forward elastic amplitude at high energy is determined by a nondegenerate factorizable J-plane pole. An iteration formula for numerical calculation of the position of the leading pole is given. The constraints imposed by demanding self-consistency between the positions and the residues of the leading input and output poles are examined. The average multiplicity of secondaries grows logarithmically with total barycentric energy in the multiperipheral model. The coefficient of logarithmic growth is given explicitly in terms of the integral kernel. Conditions on the kernel are stated which guarantee that the lead-

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ing output trajectory has positive slope at t = 0. In the strong-ordering or weak-coupling limit the trajectories are classified according to an additional quantum number m, analogous to Toller's M quantum number. Only m = 0 trajectories contribute to the total cross section. (auth)

7754 CONDITIONS FOR REGGE BEHAVIOR OF AN ABSOLUTELY CONVERGENT VENEZIANO SERIES. Frampton, P. H. (Univ. of Chicago); Gardiner, C. W. Phys. Rev., D; 2: 2378-88 (15 Nov 1970).

The conditions are investigated for the validity of a Regge asymptotic expansion of a scattering amplitude, A(s,t), which can be written in the form of an absolutely convergent series as $A(s,t) = \Sigma_{l,h=0}^{\infty} C_{lh}[\Gamma(l+h-S)\Gamma(l+h-T)]/[l!\,\Gamma(l+2h-S-T)]$, where $S = \alpha(s)$, a real linear Regge trajectory, and T is similarly defined. We find both necessary and sufficient conditions for Regge behavior when $|S| \to \infty$ at fixed T with $|\arg(-S)| < \pi$, and for Regge behavior when $|S| \to \infty$ with fixed u and $0 < |\arg(S)| < \pi$, in terms of the analyticity of two functions which are defined in terms of the coefficients C_{lh}. It is also shown that the absolute convergence of the Veneziano series is sufficient to guarantee that A(s,t) is a meromorphic function, the residues of whose poles are given by summing the residues of the corresponding pole in each term of the series. Several specific examples of Veneziano series are investigated to illustrate the utility of the methods. (auth)

7755 MULTIPARTICLE RELATIVISTIC K-MATRIX EQUATIONS AND UNITARITY. Dash, Jan W.; Pignotti, A. (Univ. of Washington, Seattle). Phys. Rev., D; 2: 2389-97(15 Nov 1970).

An extension of the work of Baker and Blankenbecler is presented in which $2 \to 2, 2 \to n$, and $m \to n$ particle amplitudes satisfy unitarity, including both elastic and inelastic terms. Disconnected parts of the $m \to n$ amplitudes are, however, not included. Dynamical applications of the model to the unitarization of meromorphic Born terms are briefly discussed. In particular, pole degeneracies are shown to be broken, and factorization of output resonance poles is proved. (auth)

7756 DUAL RESONANCE THEORY WITH NONLINEAR TRAJECTORIES. Baker, M. (Univ. of Washington, Seattle); Coon, D. D. Contracts AT(45-1)-1388; AT(11-1)-1764. Phys. Rev., D; 2: 2349-58(15 Nov 1970).

A dual resonance model with nonlinear trajectories which includes the Veneziano model as a limiting case is discussed. Rules are given for constructing the N-point function in such a model, and an explicit expression for the N-point planar tree graph is derived. A conjectured rule for loop diagrams is also presented. Representations of four-point-function satellite terms which admit straightforward generalization to the N-point function are derived. (auth)

7757 FREDHOLM CHARACTER OF THE N/D EQUATIONS. Everett, Allen E. (Tufts Univ., Medford, Mass.). Phys. Rev., D; 2: 2421-5(15 Nov 1970).

It is pointed out that, under rather general assumptions (in particular, that the Pomeranchuk singularity has either nonzero slope or intercept less than 1), unitarity guarantees that the N/D method leads to an integral equation for partial-wave amplitudes which is of Fredholm type, and hence possesses a unique solution, regardless of the behavior of the amplitude as s goes to infinity along the unphysical cut. (auth)

7758 GENERAL TREATMENT OF THE MULTIPLE FACTORIZATIONS IN THE DUAL RESONANCE MODELS; THE N-REGGEON AMPLITUDES. Yu, Loh-ping (Univ. of California, Berkeley). Phys. Rev., D; 2: 2256-64(15 Nov 1970).

A compact way of carrying out repeated factorizations on the dual amplitude is presented. Prescriptions are given for writing down the multiple-factorized tree amplitudes. As an application of the prescriptions, the N-Reggeon amplitude is derived. (auth)

7759 HIGH-ENERGY BEHAVIOR NEAR THRESHOLD: φ^3 THEORY. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Contract AT(30-1)-4101. Phys. Rev., D; 2: 2285(15 Nov 1970).

The two-body elastic scattering process is studied in φ^3 theory, in the limit $s \to \infty$ with t equal to or near the threshold value 4, where the mass of the scalar particle is taken to be unity. For the scattering amplitude corresponding to any ladder-type diagram, it is found that there is a promotion for the power of s by ½. For example, the scattering amplitude for the ladder diagram of n + 1 rungs is promoted from $O(s^{-1}\ln^n s)$ away from threshold to $O(s^{-\frac{1}{2}}\ln^{n-1} s)$ at threshold. This means that, for small coupling constants, the leading Regge pole is promoted from the neighborhood of $l = -1$ away from threshold to the neighborhood of $l = -\frac{1}{2}$ at threshold. There are, in addition, infinitely many Regge trajectories approaching $l = -\frac{1}{2}$ as t approaches 4. The scattering amplitude for the n-rung diagram is explicitly given in the limit $s \to \infty$, with t at or near the threshold 4, and various scales for $t - 4$ are pointed out. The two-rung and three-rung diagrams are especially studied in detail. (auth)

7760 HIGH-ENERGY BEHAVIOR NEAR THRESHOLD: POTENTIAL SCATTERING. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Contract AT(30-1)-4101. Phys. Rev., D; 2: 2298-2305(15 Nov 1970).

The promotion phenomenon in potential scattering is studied. The general formulas are given for the scattering amplitude at threshold, and it is shown that the asymptotic form of the scattering amplitude as the momentum transfer squared approaches infinity is determined not only by the right-hand-plane Regge poles [$\alpha(0) > -\frac{1}{2}$], but also by the left-hand-plane zeros of $Y(\lambda)$. The leading Regge pole $\alpha(k_t^2)$ is studied over the whole region $-\infty < k_t^2 < 0$ for a weak and attractive Yukawa potential, and it is found that it is indeed promoted from -1 to $-\frac{1}{2}$ within a small neighborhood of the threshold. The leading zero of $Y(\lambda)$ is obtained if the potential is repulsive. The explicit asymptotic form of the scattering amplitude is obtained. A general nth Born term is studied and it is found that its leading term is promoted from $s^{-1}(\ln s)^{n-1}$ to $s^{-\frac{1}{2}}(\ln s)^{n-2}$ at threshold. Summing over these leading terms, results are obtained, both for attractive and for repulsive potentials, off or at threshold. (auth)

7761 CONSTRUCTION OF CONVERGENT DUAL LOOPS. Bitar, Khalil M. (American Univ., Beirut, Lebanon). Phys. Rev., D; 2: 2306-12(15 Nov 1970).

Starting with a generalized representation for the multiparticle dual amplitudes, a construction of convergent dual loops is presented. This is done at the expense of a simple condition to be satisfied by the universal functions which enter into our representation. The case of nondegenerate trajectories is discussed, and it is shown that the convergence of the loops does not depend on any condition on the Regge intercepts. (auth)

7762 INTRODUCTORY REMARKS CONCERNING DUALITY. Dalitz, R. H. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A; 318: 245-55(8 Sep 1970).

From Proceedings of the Royal Society, London, England. See CONF-700916.

A historical outline of the steps leading to the notion of duality and in particular to the Veneziano model is given. In the rapid developments since then the duality concept has been used in many different senses and the equivalence of these usages has not been made clear. The discussion meeting was held in an attempt to clarify the situation. A glossary of terms commonly used in the field of duality is given. (UK)

7763 CONSTRAINTS ON THE ASYMPTOTIC BEHAVIOR OF SYMMETRIC AND ANTISYMMETRIC AMPLITUDES FROM POSITIVITY AND UNITARITY. Cornille, H. (Institut de Physique Nucleaire, Orsay, France). Nuovo Cim.; 70A: 165-74(21 Nov 1970).

Physical amplitudes constructed from linear combinations of symmetric and antisymmetric amplitudes are considered. The positivity properties of these physical amplitudes and the unitarity conditions imply some connections between the high-energy behavior of the symmetric and antisymmetric amplitudes. These constraints are investigated. (auth)

7764 CROSS-SECTION, SCATTERING AMPLITUDE, AND THE ASYMPTOTIC BEHAVIOR OF THE POTENTIAL. Villarroel, D. (Univ. of Chile, Santiago de Chile). Nuovo Cim.; 70A: 175-98(21 Nov 1970).

Two problems concerning potential scattering are investigated: (1) It is proved that the total cross section is finite for potentials with asymptotic behavior $V(x) = O(r^{-\mu})$ as $r \to \infty$ with $\mu > 2$ and that it is infinite if $\mu \leq 2$. (2) It is proved that the singular part of the scattering amplitude in the forward direction is proportional to $\ln(\sin\theta/2)$ in the case $V(x) = O(r^{-2})$ as $r \to \infty$ and that is proportional to $(\sin\theta/2)^{\mu-3}$ in the case $V(x) = O(r^{-\mu})$ with $1 \leq \mu < 3$. These results depend only on the local behavior of the potential at infinity and no hypothesis concerned with central symmetry of the potential is required. (auth)

7765 COMPLETENESS OF THE RADIAL EIGENFUNCTIONS OF ANGULAR MOMENTUM AND THE SOMMERFELD–WATSON TRANSFORMATION. Lopez, C. A. (Univ. of Chile, Santiago de Chile). Nuovo Cim.; 70A: 266-75(21 Nov 1970).

The completeness of the radial eigenfunctions of the square of the total angular momentum is considered. They correspond to solutions of the radial Schrödinger equation with complex angular momentum. The physical scattering wave function at a fixed energy and Yukawa-like potentials is expanded in terms of this

complete set. From the asymptotic behavior at large distances of this expansion the Sommerfeld–Watson formula for the scattering amplitude is obtained. The dynamical derivation is compared with the usual kinematical analysis by means of symmetry groups. (auth)

Particle Accelerators

Refer also to abstracts 6590 and 8042.

7766 (BNL-tr-377) EFFICIENCY OF MULTITURN INJECTION. Plotnikov, V. K. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report ITEF-739. 30p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 33067.

7767 (CONF-690608–, pp 111-23) FUTURE PROSPECTS FOR HIGH-ENERGY ACCELERATORS. Blewett, M. Hildred (European Organization for Nuclear Research, Geneva (Switzerland)).

A review is given on the improvements to existing accelerators; the next generation; storage rings; and accelerator technology. Accelerators now operating above 2 GeV are presented by maximum energy figures and geographic location. During the next five years, several new and exciting facilities will be available. The 200-GeV accelerator in the United States should be in operation and may later be increased to 400 GeV; hopefully, the construction of the Western European 300-GeV machine will be far advanced. The first experiments at the CERN Intersecting Storage Rings will not only give important results on proton–proton interactions but will reveal the extent to which devices of this type can be exploited for studying phenomena at very high energies. Experiments on proton–antiproton collisions at Novosibirsk may add to this knowledge. Electron–positron colliding-beam facilities at 3 GeV will extend the work already begun at lower collision energies. (Sweden)

7768 (DESY-70/51) SLOW BEAM DEFLECTION FOR DESY. Hemmie, G.; Walther, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1970. 55p. (In German). Dep. NTIS (U. S. Sales Only).

Reasons for the failure of slow third-order resonant beam extraction by using a current sheet at DESY are investigated. The theory of resonant beam ejection by the method of Y. Kobayashi and M. Month is briefly presented. Theoretical results are discussed in comparison to practical experience with the current sheet ejection. Finally approximative results of calculations for an ejection with separated functions (sextupol, quadrupol, septum) are given. (auth)

7769 (FEI-189) AUTOFOCUSING WITH A SLAVE RECTIFIER FOR AN ELECTROSTATIC ACCELERATOR. Yakushev, V. P.; Nikitin, V. A.; Serbinov, A. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomno Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1969. 10p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Autofocusing with a slave rectifier reduces significantly the lower range of working voltage of the accelerator keeping the beam focusing stable. The slave rectifier provides for focusing and beam limitation and is sufficiently reliable to be used in an electrostatic generator. In the scheme described there is lower consumption of power and less electrical insulation. (tr-auth)

7770 (IAE-1953) MULTIPLE-CHANNEL SYSTEM OF TWO-DIRECTIONAL COMMUNICATION FOR THE MEASURING CENTER AT THE CYCLOTRON WITH THE TsVM (CENTRAL COMPUTER) TYPE M-220A. Belyaev, Yu. N.; Vinogradov, A. A.; Volodenkov, A. Ya.; Kurashov, A. A.; Malygin, A. V.; Paramonov, V. V.; Salov, S. P.; Samoilov, V. D.; Foteev, V. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1970. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

A two-directional communication system for the measuring center at the IAE cyclotron with the TsVM type M-220A located in the Computer Center of the Institute is described. The information accumulated in a memory-storing device by impulse analyzer (AI) or on magnetic tape is transmitted parallel in a dual code over telephone cable. The length of the connecting line is 1,100 meters. The speed of information transmission is determined by the rapid-acting memory-storing device AI which compiles 3.10^4 18-charged words per second. Verification of the transmitted and received codes is done by comparing the controlled sums. (auth)

7771 (JUL-665-KP) RECENT DEVELOPMENT AT THE JUELICH ISOCHRONOUS CYCLOTRON. Mayer-Boericke, C. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Kernphysik). May 1970. 37p. (CONF-700428-1). Dep. NTIS (U. S. Sales Only).

From 7th European Cyclotron Progress Meeting, Eindhoven, Netherlands.

The beams of the Juelich Isochronous Cyclotron are described. The external and internal beams, extraction and matching condition, the emittance measuring device, test measurements with the external beams, and the beam-handling and monochromator system are discussed. (J.F.P.)

7772 (KFK-1268) METHOD OF CHANGING THE FIELD GRADIENTS IN ISOCHRONOUS RING CYCLOTRONS. Schatz, G. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Sep 1970. 25p. (In German). Dep. NTIS (U. S. Sales Only).

A method of adjusting isochronism in separated sector isochronous cyclotrons is investigated in some detail. By use of differently shaped magnets with different radial field increase it is possible to obtain an exactly isochronous field at two final energies without use of trimming coils. The remaining deviation from isochronism is less than a few parts in a thousand over a wide range of final energies. As an example, a 250 MeV variable energy proton accelerator is discussed in some detail. It is shown that the different types of magnets differ considerably in size and that the influence of the small magnets on the focussing properties is small. (auth)

7773 (LA-4451) LOS ALAMOS LAMB-SHIFT POLARIZED ION SOURCE: A USER'S GUIDE. Ohlsen, Gerald G. (Los Alamos Scientific Lab., N. Mex.). Feb 1970. Contract W-7405-eng-36. 22p. Dep. NTIS.

The physical and engineering information needed to effectively utilize the Los Alamos Scientific Laboratory (LASL) polarized ion source is presented. In some instances, LASL techniques are compared with others; in other instances, the discussion is applicable to all polarized ion source types. (auth)

7774 (NP-18586) CIRCULATING BEAM CURRENT MONITOR. Unser, K. (European Organization for Nuclear Research, Geneva (Switzerland)). 5 Mar 1968. 22p. Dep. NTIS (U. S. Sales Only).

The circulating beam current monitor (CBCM), a device for measuring the instantaneous value of the circulating proton beam current in the CERN proton synchrotron (PS), is described. The CBCM uses a combination of toroidal transformers as input sensors. The beam (and the vacuum vessel) passes through the aperture of these transformers to form a single turn primary winding. The CBCM has excellent long-term stability, high accuracy calibration is easily performed in situ and it has a very large bandwidth, extending from about 10^{-4} Hz to several tens or possibly hundreds of megahertz. These features are combined with excellent linearity and a wide dynamic range (about 60 dB), without range switching. (W.H.K.)

7775 (UCRL-19901) METHOD FOR OBTAINING LINAC BEAMS OF CONTINUOUSLY VARIABLE ENERGY. Selph, Frank B. (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1970. Contract W-7405-eng-48. 13p. (CONF-700929-2). Dep. NTIS.

From Proton Linear Accelerator Conference, Batavia, Ill.

The beam energy obtained with an Alvarez linac is normally determined within narrow limits by the design energy of the synchronous particle. In the SuperHilac poststripper the tank is divided into several separately excited sections. In each section varying the electric field from zero to maximum causes the energy increment of that section to vary from zero to the maximum (synchronous value). By so adjusting each of 5 sections, the output energy can be varied continuously from 2.6 to 8.5 MeV/N. Some aspects of the expected behavior of the partial energy beams are discussed—particularly the energy spread. A formula is suggested whereby results obtained for the heavy ion linac can be scaled to predict variable energy performance of other linacs. (auth)

7776 (UCRL-19932) EFFECT OF DRIFT TUBE TOLERANCES ON THE ELECTRIC FIELD DISTRIBUTION ALONG THE LENGTH OF AN ALVAREZ CAVITY. Halbach, Klaus (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1970. Contract W-7405-eng-48. 11p. (CONF-700929-1). Dep. NTIS.

From Proton Linear Accelerator Conference, Batavia, Ill.

An analysis is presented that shows how small random errors of drift tube diameters, lengths, and positions perturb the electric field distribution in an Alvarez cavity. The field distribution

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due to the tolerances is calculated from the change of the resonance frequency of individual cells, taking the correlation of the detuning of adjacent cells into account. For all cells, the rms field errors and their correlations are calculated. From this is deduced the maximum rms tilt and the most probable distribution of the error fields throughout the cavity. The change of the resonance frequency of the whole cavity is also calculated. Using a different representation, the rms values of the Fourier coefficients of the field, and their correlations, are given. (auth)

7777 (UCRL-20084) ELECTRON RING ACCELERATOR PROGRAM AT THE LAWRENCE RADIATION LABORATORY. McMillan, Edwin M. (California Univ., Berkeley. Lawrence Radiation Lab.). 18 Aug 1970. Contract W-7405-eng-48. 20p. (CONF-700806-52). Dep. NTIS.

From 15th International Conference on High Energy Physics, Kiev, USSR.

Work at LRL on the electron-ring accelerator is outlined. The experimental program including the new injector facility is briefly discussed; and future possibilities of the electron-ring accelerator are considered. (W.H.K.)

7778 (UCRL-20131) POSSIBLE CONTAMINATION OF GROUND WATER SYSTEM BY HIGH ENERGY PROTON ACCELERATORS. Thomas, Ralph H. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct 1970. Contract W-7405-eng-48. 21p. (CONF-701106-4). Dep. NTIS.

From Symposium of the Health Physics Society, Idaho Falls, Idaho.

A general evaluation of the problem of possible ground water contamination due to the release of accelerator produced radionuclides to ground shows it to be an unlikely problem for existing and projected high energy accelerators in the energy region of several hundred GeV. (auth)

7779 TEN NANOSECOND PULSING HEAD FOR THE VAN DE GRAAFF ACCELERATOR. Sawicki, Aleksander; Orzechowski, Tadeusz (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 15: 129-30(1970).

The D.C. electron Van de Graaff accelerator of the Radiation Damage Group of the Laboratory II at Świerk was adapted in 1966 for pulse irradiation at a one microsecond pulse width. During the experiments a need arose for much shorter pulse irradiation. A pulsing head electronic circuitry was therefore designed and constructed, which provides for the following parameters of the assembly to be reached: (1) D.C. operation of the accelerator with the control of the beam current; and (2) Pulse operation: pulse width — 10 nanosecond or 20 μs (selected), pulse intensity — controllable in the range of 0 to 400 mA, and repetition rates — variable in the range from 0 to 90 pps (single pulse operation also possible). (auth)

7780 MULTI-PERIODIC ACCELERATING STRUCTURE. Giordano, Salvatore (to United States Atomic Energy Commission). U. S. Patent 3,530,332. 22 Sep 1970. Filed 20 May 1969.

A multi-periodic charged particle accelerator apparatus and method having a cylindrical, Alvarez-type, accelerator tank formed with a plurality of spaced-apart drift tubes is described. The tubes are supported by supporting stems and have multiple periodic tuning means at periodic, spaced intervals in said tank for producing transverse stem resonances for reducing detuning and beam loading effects. They also provide tank stiffening that reduces field variation due to frequency perturbation, while reducing power consumption and mechanical complexity. (auth)

7781 HIGH-INTENSITY ELECTRON BEAMS IN ACCELERATOR TUBES WITH STRONG FOCUSING. Abramyan, E. A.; Vecheslavov, V. V.; Gaponov, V. A.; Rezakov, A. M. This paper was summarized in At. Energ. (USSR); 25: 135(Aug 1968) as paper No. 217. (In Russian).

A sharp increase in the intensity of an electron beam obtained with a strong focusing accelerator can be achieved in tubes with the usual dimensions if a system of strong focusing magnets is placed inside this device. Calculation is performed for a system designed to shape an electron beam with a current of 50 A in a filament having a diameter no greater than 16 mm. Calculation results and design schemes are given for an energy of 1 MeV since beam transport upon further acceleration is carried out similarly. The mean potential gradient along the tube is 13 kV/cm. For a beam current of 50 A or more in the channel an injection energy of 300 keV is required. The particles acquire this energy in an electron gun with a spherical cathode and three Pierce electrodes. Two variants of focusing systems are considered: those with quadrupole lenses and those with axially symmetric lenses constructed with permanent magnets. (W.H.K.)

7782 SECONDARY ELECTRON CHARACTERISTICS OF ACCELERATOR TUBES WITH STRONG FOCUSING. Vecheslavov, V. V.; Kononov, V. I. This paper was summarized in At. Energ. (USSR); 25: 135-6(Aug 1968) as paper No. 218. (In Russian).

The secondary electron characteristics of various focusing systems for accelerator tubes for intense proton beams are determined by analyzing the calculated trajectories of random particles (secondary electrons). Magnetic quadrupole lenses, electrostatic quadrupole lenses, and axially symmetric magnetic lenses are studied. (W.H.K.)

7783 RADIAL SELF-FOCUSING OF AN ELECTRON-ION BEAM MOVING ALONG A MAGNETIC FIELD. Krasovitskii, V. B. This paper was summarized in At. Energ. (USSR); 26: 458-9(May 1969) as paper No. 302. (In Russian).

The conditions necessary for radial self-compression of an electron beam with ions captured in an electron potential well are presented. The stability of the system relative to the excitation of nonaxially-symmetric waves with field components E_ϕ E_r, and H_z is studied. (W.H.K.)

7784 PROTON RELAXATION RATES AND POLARIZATION MEASUREMENTS IN BUTANOL/WATER SAMPLES AT 25kG. Nicholas, D. J.; Banks, P. H. T.; Cragg, D. A. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods; 88: 69-71 (1970).

Proton relaxation rates and polarization measurements have been made at 25 kG and over the temperature range $0.28\ K \leq T \leq 1.5°K$ for a 1 g sample of 1-butanol-water eutectic mixture containing varying concentrations of the free radical porphyrexide. Proton polarizations in the range 30-60% have been measured and the polarization found to increase with decrease in temperature. Proton relaxation rates as low as 1.1×10^{-4}/sec have been measured at 0.28 K. The results obtained are used to assess the suitability of this hydrocarbon as a possible target material for a separated function polarized target. (auth)

7785 PROTON POLARIZATION AND RELAXATION TIMES BELOW 1 K FOR GLYCEROL:WATER DOPED WITH PORPHYREXIDE. Williams, W. G.; Nicholas, D. J.; Banks, P. H. T.; Cragg, D. A. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods; 88: 73-6(1970).

High proton polarizations and long relaxation times have been observed in 50:50 mixtures of glycerol and water containing porphyrexide by using the solid effect. Results are reported for temperatures down to 0.28 K, and for magnetic fields between 19.6 and 29.4 kG. Comments are made on this material with regard to its suitability for use as a "frozen target" material. (auth)

7786 CALIBRATION TECHNIQUE FOR ENERGY-DEFINING TRANSPORT MAGNETS. Kenefick, R. A.; Hiebert, J. C.; Lewis, C. W. (Texas A and M Univ., College Station). Nucl. Instrum. Methods; 88: 13-16(1970).

By matching pulse heights from a solid-state detector, beams of identical velocity but different charge state have been used to calibrate a beam analyzing magnet over a range of Bp values. No assumptions need be made about linearity of response of the detection system. The standard of calibration was a time-of-flight measurement which limited the energy accuracy to 1/2000. However, a thin α source (^{212}Po monolayer) will allow an energy accuracy limited by electronic stability, which may approach 1 part in 10,000. The calibration points may range over the whole spectrum of magnetic rigidity capabilities of the associated accelerator. (auth)

7787 CHAIN AND INDUCTIVE CHARGING SYSTEM AS A CHARGE-CARRYING ELEMENT OF THE ELECTROSTATIC GENERATOR. Isoya, A.; Nakashima, T. (Kyushu Univ., Fukuoka). Nucl. Instrum. Methods; 88: 33-43(1970).

A charge-carrying element or chain, for the electrostatic generator, which can be charged or discharged by the electric induction method, has been developed and used in the generator of the Kyushu University with excellent performance. High stability and durability of this system has been well tested through the operation in the last few years. This charge-carrying system is particularly suitable for use in an insulation gas, like freon-12 or SF_6, which has a high dielectric strength but is easily decomposed by corona discharge. Fluctuation of the charge carried by the chain, or that of the generated voltage, is extraordinarily small. The chain is well protected against the external surges since the series of metal rings of the chain serve as spark gaps to prevent damage of the internal insulator. The highest voltage so far obtained with this charging system was 8.9 MV (the height of the stack is 5 m). (auth)

7788 BEAM-SAFETY CONSIDERATIONS AT THE STANFORD LINEAR ACCELERATOR CENTER. Jenkins, T. M.; Bus-

ick, D. D.; McCall, R. C.; (and others) (Stanford Linear Accelerator Center, Palo Alto, Calif.). Nucl. Safety; 11: 435-44 (Nov-Dec 1970).

The Health Physics Department at the Stanford Linear Accelerator Center (SLAC) actively participates with the Research Area Department in problems related to safe beam transport and shielding. The result of such planning and design is set forth in an operational document known as the Beam Authorization Sheet, which, along with the Radiation Rule Book, provides the guidelines through which the accelerator, beam switchyard, and research area are operated safely. Planning and operational phases of radiation protection at SLAC include (1) primary electron- and positron-beam containment, (2) control of dangerous secondary-beam areas and any that are potentially dangerous, (3) radiation and shielding calculations, (4) beam check-out procedures and measurements, and (5) routine monitoring. Several classic examples illustrate the ingenuity required to satisfy the safety criteria established at SLAC, and the information presented should be of particular interest to those who are planning new accelerators. (auth)

7789 NEW USES FOR LOW-ENERGY ACCELERATORS. Parker, P. D. (Yale Univ., New Haven). Particle Accel.; 1: 285-310 (Oct 1970).

The areas of nuclear astrophysics, beam-foil spectroscopy, and solid-state physics are discussed as examples of interdisciplinary fields where there is exciting and important research which is accessible to low-energy accelerators and which is ripe for harvest by workers with training in nuclear physics techniques and with interest in these areas of the scientific frontier. Along with a presentation of the concepts and the important problems in these areas, the techniques and hardware necessary for research in these areas are also described and discussed. (109 references) (auth)

7790 INITIAL PERFORMANCE OF NEW BROOKHAVEN LINAC. Wheeler, George W.; Batchelor, Kenneth; Sluyters, Th. J. M. (Brookhaven National Lab., Upton, N. Y.). Particle Accel.; 1: 355 (Oct 1970).

The first section of the BNL 200-MeV proton linac has been successfully operated, accelerating a current of 200 mA to 10 MeV. Operational equipment and beam monitoring and analysis equipment are briefly described. (W.H.K.)

7791 OSCILLATING ION ORBITS IN SYNCHROCYCLOTRONS. LeVine, D. M. (Univ. of Maryland, College Park). Particle Accel.; 1: 347-53 (Oct 1970).

During a numerical investigation of the ion capture process in synchrocyclotrons, ion orbits were encountered which are characterized by oscillation of the radius about a fixed value. These ion orbits appear to represent a generally overlooked intermediate state between capture and return to the ion source which appears to be inherent to synchrocyclotrons. In the cases investigated, ions went into oscillating orbits during a significant portion of the rf modulation cycle and many remained in oscillating orbits for more than one cycle of the rf program. Solutions which correspond to these oscillating orbits have been found for the linearized equations of motion and on the basis of these solutions stability criteria have been developed. (auth)

7792 EXPERIMENTAL STUDY OF THE PROPAGATION OF AN ELECTROMAGNETIC WAVE THE LENGTH OF A HELICAL CONDUCTOR: INFLUENCE OF THE WIRE THICKNESS ON THE PHASE VELOCITY. Crouzet, J. (CERN, Geneva). Particle Accel.; 1: 335-45 (Oct 1970). (In French).

An experimental study of the influence of the wire thickness on the phase velocity of electromagnetic waves on a helical conductor is described. Practical details on the measurements are thoroughly indicated. The results obtained show a very weak sensitivity of the phase velocity of the electromagnetic waves upon the conductor thickness and are only in relative agreement with present theories. (auth)

7793 DECAY OF IMAGE CURRENTS AND SOME EFFECTS ON BEAM STABILITY. Bodner, Stephen; Neil, V. K.; Smith, Lloyd (Univ. of California, Livermore). Particle Accel.; 1: 327-34 (Oct 1970).

An unneutralized beam of particles is suddenly established off-axis in a conducting tube of circular cross section, and the time-dependent magnetic field of the image currents is investigated theoretically. The system is infinite in the axial direction. The tube wall has conductivity σ, inner radius b, and thickness τ. The calculation is valid to first order in the displacement of the beam axis of the tube. For $\tau/b \lesssim 0.1$ it is shown that 94% of the image field decays with a time constant $2\pi\sigma b\tau/c^2$, where c is the speed of light. The remaining portion of the field decays more rapidly. These results are then applied to a beam in an accelerator, and the effects of the time-dependent field on the dynamics of the beam are treated. As this field decays, the beam can cross an integral resonance, with the result that the displacement of the beam grows exponentially. An expression for the growth rate is presented. (auth)

7794 LONGITUDINAL INSTABILITIES OF CHARGED PARTICLE BEAMS INSIDE CYLINDRICAL WALLS OF FINITE THICKNESS. Zotter, B. (CERN, Geneva). Particle Accel.; 1: 311-26 (Oct 1970).

The stability of coherent longitudinal oscillations of coasting particle beams in accelerators or storage rings can be described in terms of the dispersion relation coefficients which are a measure of the force exerted by an oscillating beam upon itself. These coefficients are calculated with the help of an algorithm valid for beams of circular cross section inside a concentric vacuum chamber consisting of an arbitrary number of layers of various materials. Two cases of practical importance are discussed in more detail: (1) the metal wall of finite thickness, for which the dispersion relation coefficients at all frequencies are found to be less than or of the same order of magnitude as those for an infinite thick wall at the lowest mode number, and (2) the ceramic wall, where dielectric resonances may increase the dispersion relation coefficients by several orders of magnitude at certain frequencies, for which the wall thickness is approximately an odd multiple of a quarter of a wavelength in the dielectric. These resonances can be damped effectively by thin layers of metal deposited on the inside of the ceramic. (auth)

7795 METHOD FOR THE CALIBRATION OF SYNCHROTRON BEAM PICKUP ELECTRODES. Baron, A. L.; Vogel, U. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum.; 41: 1832-6 (Dec 1970).

A method is described for the measurement of characteristics of pickup electrodes (PUE) for monitoring coordinates of an accelerator beam. A new representation is discussed for determining the coordinates of the center of charge for the entire PUE aperture. A few prototypes of PUE's to be installed in the AGS were tested and the results show that nonlinear deviations are at least 1 mm/25 mm. The method of measurement has a resolution of at least 0.1 mm/25 mm; it can therefore be used for (a) the design of high quality PUE's and (b) calibration of PUE's as installed in the accelerator in order to increase the usable aperture and the accuracy of beam coordinate monitoring. (auth)

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PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 6589 and 7440.

7796 (AWRE-O-74/70) MULTIGROUP NEUTRON DIFFUSION THEORY PERTURBATION PROGRAM SPECTRE. Hemment, Pamela C. E.; Pendlebury, E. D.; West, P. H.; Wilson, W. H. G. (Atomic Weapons Research Establishment, Aldermaston (England)). Sep 1970. 39p. Dep. NTIS (U. S. Sales Only). UK 5s. 6d. (28p).

A description is given of the IBM 7030 (STRETCH) program SPECTRE in which Usachev's perturbation method is used to obtain the sensitivity of the neutron flux at the center of a system, as calculated by multigroup diffusion theory, to changes in neutron cross section data. SPECTRE uses, as part of its input, perturbation functions (on tape) calculated by a program SWAN-DP. The output from SPECTRE is on tape, which is used with the optimization program PENICUIK to calculate adjustments to cross sections to make them consistent with various types of integral measurements. (auth)

7797 SINUSOIDAL NEUTRON SOURCE BY PULSE FREQUENCY MODULATION OF A PULSED NEUTRON SOURCE. Yasuda, Hideshi; Sanda, Toshio; Sumita, Kenji (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 381-3(Jul 1970).

A pseudo-sinusoidal neutron source is constructed by operating a conventional pulsed neutron source with pulse frequency modulation. The advantages of this method are ease of modulation of any desired frequency, wide applicable range of modulating frequency, visible display of gain and phase lag by multi-channel time analyzer, and good linearity between modulating voltage and the produced neutron wave. The feasibility of the method is demonstrated by measuring the frequency-dependent neutron transfer characteristics of an acrylite medium. (R.W.R.)

7798 DISCUSSION OF THE QUASI-ELASTIC SCATTERING OF NEUTRONS IN INCOHERENT LIQUIDS. Purohit, S. N. (Aktiebolaget Atomenergi, Studsvik, Sweden). Phys. Chem. Liquids; 1: 13-32(Feb 1968).

A critical discussion of the quasi-elastic scattering of neutrons by incoherent (hydrogenous) liquids is presented. By using the line shape expression a comparative discussion of several phenomenological models is undertaken. Extension of the Singwi–Sjolander zero-phonon expression for the jump-diffusion model to include the one-phonon expression is also given. For a delayed-diffusion model a complete treatment of $S(K, \omega)$ is presented. Along the lines of the macroscopic diffusion cooling, a microscopic diffusion cooling effect in fluids is speculated. (auth)

7799 OPTIMIZATION OF RESULTS OBTAINED FROM INTEGRALS OVER POISSON DISTRIBUTED DATA. I. OPTIMAL CORRELATION FUNCTIONS FROM ELASTIC NEUTRON SCATTERING DATA IN SIMPLE LIQUIDS. Schlup, Werner A. (Columbia Univ., New York). Phys. Chem. Liquids; 1: 73-91(Feb 1968).

It is shown how the counting time at different scattering angles in particle-scattering experiments has to be chosen so that a physical quantity given by an integral over Poisson-distributed data may be optimally determined, i.e., with the smallest possible uncertainties. The method is applied to the elastic scattering of thermal neutrons by liquid argon. The optimal angle or time distribution of the measurements for obtaining the total and direct particle correlation functions has been calculated from the known data. The result may be used as a starting point for improved measurements. (auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 7686 and 7912.

7800 (EANDC(E)-127(U)) PROGRESS REPORT ON NUCLEAR DATA RESEARCH IN THE EURATOM COMMUNITY FOR THE PERIOD JANUARY 1–DECEMBER 31, 1969. (European American Nuclear Data Committee). Mar 1970. 260p. Dep. CFSTI (U. S. Sales Only).

Progress on nuclear data research in the Euratom community during 1969 is reported. The work was done at 24 institutions in the Netherlands, Germany, Italy, France, and Belgium. (J.W.R.)

7801 EFFECT OF d + d FINAL-STATE INTERACTIONS ON THE $^4He(\gamma,d)^2H$ CROSS SECTION. Thompson, D. R. (California Inst. of Tech., Pasadena). Nucl. Phys.; A154: 442-8(1970).

The cross section for the reaction $^4He(\gamma,d)^2H$ was calculated using the relative function for the final state deuterons obtained from a previous resonating-group calculation. It is found that the present calculation, which employs an Irving–Gunn function that gives the proper rms radius for ^4He, agrees with the experimental data, while a calculation using a plane wave relative function cannot fit all the data even when the α-particle size is treated as a variable parameter. (auth)

7802 ENERGY DEPENDENCE OF QUASIFREE SCATTERING IN DEUTERON BREAKUP BY PROTONS. Margaziotis, D. J. (California State Coll., Los Angeles); Paic, G.; Young, J. C.; (and others). Phys. Rev., C; 2: 2050-6(Dec 1970).

The quasifree scattering process (QFS) was studied in the reaction D(p,2p)n at incident energies of 14, 17, 20, 23, 33, 38, 45, and 57 MeV at $\theta_L = \theta_R = 43°$ (left and right) to the incident beam and $\phi_{LR} = 180°$. The QFS peak cross section remains almost constant from 20 to 100 MeV and begins to drop at lower energies. The magnitude of the cross section, as well as the shape of the QFS peak, is compared with predictions of a modified-simple-impulse-approximation calculation including a cutoff radius. The energy dependence of the QFS peak cross section is compared with the corresponding cross sections of the reaction D(p,pn)p and to the free nucleon–nucleon elastic scattering cross sections. (auth)

7803 PROTON–NEUTRON FINAL-STATE INTERACTIONS IN THE D(d,dp)n REACTION. von Witsch, W.; Ivanovich, M.; Rendic, D.; Sandler, J.; Phillips, G. C. (Rice Univ., Houston, Tex.). Phys. Rev., C; 2: 2144-8(Dec 1970).

The reaction D(d,dp)n was studied at bombarding energies between 11 and 13 MeV. Two charged particles were detected in coincidence at pairs of angles corresponding to the recoil axes of the reaction D(d,d)d* where d* is a p-n system at zero relative energy. Time-of-flight and ΔE-E information were used for background subtraction and particle identification, respectively. The experimental spectra are dominated by strong peaks at low relative energies in the p-n system which are in part attributable to the isospin-forbidden formation of the "singlet deuteron." The shape of the experimental spectra is not predicted very well by either Watson–Migdal or Phillips, Griffy, Biedenharn theories. (auth)

7804 ELASTIC SCATTERING OF 36.0- AND 46.3-MeV NEUTRONS FROM DEUTERIUM. Romero, Juan L.; Jungerman, J. A.; Brady, F. P.; Knox, W. J.; Ishizaki, Y. (Univ. of California, Davis). Phys. Rev., C; 2: 2134-44(Dec 1970).

The differential cross sections for elastic scattering of 36.0- and 46.3-MeV neutrons from deuterium were measured over an angular range of 15 to 170° cm. The cross section agrees well in shape and absolute value with that for p-d scattering. A slightly more pronounced minimum seems to be present in the n-d results. From measured values of the total n-d cross sections, the values 154 ± 6 and 116 ± 5 mb at 36.0 and 46.3 MeV were obtained, respectively, for the n-d nonelastic cross section. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 7397, 7555, 7800, 7838, and 7912.

7805 (AD-707047) ELASTIC ELECTRON SCATTERING FROM ^{12}C AND ^{16}O. Sick, I.; McCarthy, J. S. (Stanford Univ., Calif. High-Energy Physics Lab.). Oct 1969. Contract Nonr-225(67). 52p. (HEPL-617). NTIS.

Electron scattering cross sections for carbon and oxygen between q ± 1 F^{-1} and 4 F^{-1} are given. The data are analyzed in terms of a phenomenological charge distribution, and new information concerning the tail and the center of the charge distribution is obtained. The presence of dispersion effects appears to be necessary to explain the cross sections in the first diffraction minimum. The effect of a finite potential and short-range correlations on the form factor is discussed. (auth) (USGRDR)

7806 (BMBW-FBK-70-14) ANNUAL REPORT, 1967/68. (Tuebingen Univ. (West Germany). Physikalisches Institut). Aug 1970. 103p. (In German). Dep. NTIS (U. S. Sales Only).

The following experiments are reported: neutron polarization in the elastic and inelastic scattering of neutrons on ^{12}C and in the reaction $^{3}H(d,n)^{4}He$; angular distributions and analyzing power of (n,α)-reactions on ^{142}Nd, ^{140}Ce, ^{139}La, ^{138}Ba, ^{64}Zn, ^{54}Xe and ^{12}C; mass, energy and angular distribution of fission fragments in $^{238}U(n,f)$ and $^{232}Th(n,f)$; interaction of nuclear multipole moments with atomic electrons by HFS-investigations on ^{23}Na, ^{171}Yb and ^{173}Yb; and investigation of the elementary process of bremsstrahlung production by electrons in the Coulomb field of the nucleus. (auth)

7807 (NYO-2171-327) CLUSTER MODEL VERTEX FUNCTIONS FOR ^{16}O: BACKWARD α-PARTICLE SCATTERING. Noble, J. V.; Coelho, H. T. (Pennsylvania Univ., Philadelphia. Dept. of Physics). [1970]. 31p. Dep. NTIS.

It is shown by direct calculation that the heavy-particle transfer model of backward elastic α-particle scattering, together with the assumption of α-cluster structure of ^{16}O and ^{12}C, is capable of explaining the large backward peak in elastic α-scattering from ^{16}O. (auth)

7808 (UCRL-19530, pp 53-106) NUCLEAR REACTIONS AND SCATTERING. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

BERYLLIUM-8—energy levels from resonances in helium-4 alpha scattering, high-lying, (E)
BISMUTH-207—energy levels from lead-206 (He-3,d) reactions
BISMUTH-209—energy levels from lead-208 (He-3,d) reactions
BORON-10—proton inelastic scattering at 30.3 MeV, proton spectra and differential cross sections for, (E)
COBALT-56—energy levels from nickel-58 (p,He-3) reactions, spin-parity assignments for, (E)
HELIUM-4—proton scattering at 20 to 60 MeV, analysis of cross-section and polarization data for
HELIUM-4—alpha elastic scattering at 30 to 70 MeV, excitation formations for, (E)
LEAD-206—helium-3 reactions (He-3,d) at 35 MeV, deuteron spectra and angular distributions for, (E)
LEAD-208—helium-3 reactions (He-3,d) at 35 MeV, deuteron spectra and angular distributions for, (E)
NEON-20—proton inelastic scattering at 24.5 MeV using polarized beams, analyzing power for, (E)
NICKEL-56—energy levels from nickel-58 (p,t) reactions, spin-parity assignments for, (E)
NICKEL-58—proton reactions (p,He-3) and (p,t) at 45 MeV, spectra and angular distributions for, (E)
STRONTIUM-88—alpha reactions (α,d) at 40 MeV, deuteron energy spectrum from, (E)
TITANIUM-43—helium-3 reactions (He-3,2n) and (He-3,pn) with, excitation functions for, (E)
TITANIUM-46—alpha reactions (α,2n) and (α,pn) with, excitation functions for, (E)
URANIUM—proton fission at 5.5 GeV, energy spectra and angular distributions of fragments from, (E)
ZIRCONIUM-90—alpha reactions (α,d) at 40 MeV, deuteron energy spectrum from, (E) (J.W.R.)

7809 ELECTRON SCATTERING SUM RULE FOR ^{12}C: EXPERIMENT AND THEORY. Lightbody, J. W. Jr. (National Bureau of Standards, Washington, D. C.). Phys. Lett.; 33B: 129-32(28 Sep 1970).

Inelastic electron-scattering cross sections for ^{12}C are integrated to form the longitudinal and transverse sums as a function of momentum transfer. Comparison is made with sum rules calculated in the harmonic-oscillator model. The various two-body correlation functions that enter the sum are evaluated for ^{4}He, ^{12}C, and ^{16}O in the oscillator model. (auth)

7810 INVERSE PHOTONUCLEAR REACTIONS IN THE UPPER PART OF THE 1p SHELL. O'Connell, William John. Stanford, Calif.; Stanford Univ. (1969). 121p. University Microfilms Order No. 70-10,498.

Thesis.

The yield and angular distributions of the reaction $^{15}N(p,\gamma_0)^{16}O$ were measured from E_x = 20 to 29 MeV. In this region the total yield is falling slowly with energy and the angular distributions vary smoothly, with $a_2 \approx -0.55$, $a_3 \approx -0.15$, and a_1 slowly rising from 0.20 to 0.36. It is found that the observed structures can be attributed to interference between the following 1^- resonances: the principal giant resonance states at E_x = 22.16 and 25 MeV and three narrower states (300–500 keV wide) correlated in energy and width with 1^- states in ^{16}O seen in heavy particle capture reactions at E_x = 21.06, 22.78, and 24.07 MeV. The structure around E_x = 24.8 MeV may be correlated with a resonance in $^{15}N(p,\gamma')$ seen at that energy. The reactions $^{15}N(p,\gamma_1 \rightarrow \gamma_4)^{16}O$ (with the gamma rays unresolved) and $^{15}N(p,\alpha\gamma_{15,11})^{12}C$ were studied in order to observe other T = 1 resonances in ^{16}O. The giant dipole resonances in ^{15}O and ^{14}N were studied through the reactions $^{14}N(p,\gamma)^{15}O$ and $^{13}C(p,\gamma)^{14}N$. The results can be compared with those in similar nuclei through isospin considerations, understood qualitatively by shell model arguments, and compared with recent theoretical calculations. It is found that the $^{15}O(\gamma,p_0)$ and $^{14}N(\gamma,p_0)$ cross sections are only a small part of the (γ,total) yield and smaller than the $^{16}O(\gamma,p_0)$ yield. The $^{15}O(\gamma,p_0)$ reaction peaks at a lower energy than $^{15}N(\gamma,p_0)$ or the total giant resonance of the A = 15 nuclei in accord with recent theoretical calculations. The angular distribution coefficients are similar for all three (p,γ_0) giant resonances studied and similar to those in $^{11}B(p,\gamma_0)^{12}C$. The $^{13}C(p,\gamma_1)^{14}N^*$ (0^+,T = 1) yield was also observed. It is rather structureless and has about $\frac{1}{4}$ the average yield of $^{13}C(p,\gamma_0)$. The $^{14}N(p,\gamma_1)$ reaction is not seen. Its yield is less than 10% of that of $^{14}N(p,\gamma_0)$ in those energy regions where the (p,γ_1) yield might be seen unobscured by background. (Diss. Abstr. Int., B)

7811 185-MeV PROTON SCATTERING FROM ^{6}Li AND THE IMPULSE APPROXIMATION. Hutcheon, R. M. (Univ., Mainz); Sundberg, O.; Tibell, G. Nucl. Phys.; A154: 261-72 (1970).

Cross sections for the scattering of 185-MeV protons from ^{6}Li were measured for the elastic case and for inelastic excitation of the first two excited states. These cross sections are compared with plane-wave impulse approximation calculations in which the nuclear matrix elements are taken directly from electron scattering data in order to eliminate model dependence. The experimental to theoretical cross-section ratio is 0.5 ± 15% for a momentum transfer of 0.7 fm^{-1} and has a strong momentum-transfer dependence. Previous calculations made in the distorted wave impulse approximation bring the ratio closer to unity but do not lead to complete agreement. (auth)

7812 PLANE-WAVE MODEL FOR THE (^{7}Li,t) ALPHA TRANSFER REACTION. Neogy, P.; Scholz, W.; Garrett, J.; Middleton, R. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 2: 2149-54(Dec 1970).

Differential cross sections for the (^{7}Li,t) reaction on ^{16}O, ^{18}O, and ^{20}Ne at bombarding energies between 12 and 20 MeV were analyzed with a finite-range plane-wave direct-reaction model. Sixteen triton angular distributions leading to strongly excited states in ^{20}Ne, ^{22}Ne, and ^{24}Mg were selected so as to test the model over an extended range of reaction Q values, angular momentum transfers, and incident beam energies. The projectile form factor was evaluated using a phenomenological p state α-plus-triton cluster-model wave function. Coulomb-distortion effects were accounted for in the local-energy WKB approximation. Relative α cluster widths were extracted and the effects of the structure of the projectile on the reaction process are discussed. Results of the analysis show that the model gives an adequate description of the shape of the angular distributions and the kinematic dependence of cross sections. (auth)

7813 SEARCH FOR PARITY NONCONSERVATION IN THE FORCE BETWEEN NUCLEONS. Jones, C. M. (Oak Ridge National Lab., Tenn.); Ford, J. L. C. Jr.; Obenshain, Felix E.; Reeves III, Mark. Phys. Rev., C; 2: 2113-17(Dec 1970).

An experiment to search for the parity-forbidden α decay of the 8.87-MeV state in ^{16}O was performed. No evidence of this decay was observed. Assuming a laboratory radiation width of 3.43×10^{-3} eV for the 8.87-MeV state, we find the laboratory α-decay width to be less than 2.1×10^{-9} eV with a 95% confidence limit. (auth)

7814 STATES IN ^{12}B OBSERVED IN THE SCATTERING OF NEUTRONS BY ^{11}B. Lane, R. O. (Ohio Univ., Athens); Nelson, C. E.; Adams, J. L.; (and others). Phys. Rev., C; 2: 2097-2105 (Dec 1970).

The polarization $P(\theta)$ and differential cross section $\sigma(\theta)$ for the scattering of neutrons by ^{11}B were measured for $0.075 \leq E_n \leq 2.2$ MeV. Both $\sigma(\theta)$ and $P(\theta)$ are simultaneously fitted reasonably well by R-matrix parameters for broad states in ^{12}B with assignments 2^- (l = 0) and 4^- (l = 2) at excitation energies E_x = 4.37 and 4.54 MeV, respectively. The 2^- level has not previously been observed, while the 4^- level has previously been assigned to be 3^-. These results, together with a previous 3^- assignment for a state at E_x = 3.39 MeV, give experimental evidence for proton-hole–neutron-particle shell-model configurations $(1p_{\frac{1}{2}})^{-1}$ $(1d_{\frac{5}{2}})$ and $(1p_{\frac{1}{2}})^{-1}$ $(2s_{\frac{1}{2}})$ in ^{12}B. Shell-model calculations were made with σ-function residual interactions and include configuration mixing of the resulting 2^- states. Work on T = 1 states in $^{12*}C$ was compared with the present work. (auth)

7815 STUDY OF PARTICLE-EMITTING STATES IN ^{12}N AND ^{12}C FORMED IN REACTIONS OF ^{10}B WITH HELIONS.

Bohne, W.; Hagen, M.; Homeyer, H.; (and others) (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Rev., C; 2: 2072-81(Dec 1970).

The following reactions were studied. At E_h = 6.2 MeV: $^{10}B(h,n)^{12}N$. At E_h = 10 and 11 MeV: $^{10}B(h,n)^{12}N(p)^{11}C$, $^{10}B(h,p)^{12}C(n)^{11}C$, $^{10}B(h,p)^{12}C(p)^{11}B$, $^{10}B(h,p)^{12}C(\alpha)^{8}Be$, $^{10}B(h,p)^{12}C(d)^{10}B$. States at 5.3 MeV in ^{12}N and 20.5 MeV in ^{12}C were identified as members of an isobaric triad, with J^π, T = 3^+, 1 having a pronounced two-particle structure. Angular correlations support this assignment. For these and other states, branching ratios of the emitted particles are measured, and conclusions on isospin purities and other properties are drawn. (auth)

7816 EVIDENCE OF E2 AND M1 TRANSITIONS IN HIGH-ENERGY PHOTONUCLEAR REACTIONS IN ^{16}O. Mustafa, M. G. (Yale Univ., New Haven); Malik, F. B. Phys. Rev., C; 2: 2068-72(Dec 1970).

The observed forward-peaked angular distributions and polarization at 90° of photonucleons from ^{16}O are ascribed to the interference of E1 and (E2 + M1) transitions within the context of a direct-reaction model, using wave functions computed in a Woods-Saxon potential. (auth)

7817 SCATTERING OF HIGH-ENERGY ELECTRONS BY ^{14}N AND ^{15}N. Dally, E. B. (Stanford Univ., Calif.); Croissiaux, M. G.; Schweitz, B. Phys. Rev., C; 2: 2057-68(Dec 1970).

Cross sections of elastic and inelastic electron scattering at incident electron energies of 250 and 400 MeV are presented. Data are given for elastic and inelastic scattering from ^{15}N and elastic scattering from ^{14}N. The data are analyzed with the use of the shell model, in Born approximation. The rms radius of ^{14}N is found to be 2.64 F at 400 MeV. The rms radius of ^{15}N at 250 and 400 MeV is 2.65 and 2.63 F, respectively. Excited levels in ^{15}N at 5.3, 6.3, and 7.3 MeV are studied. Values of the nuclear transition probabilities are presented for these levels. The spin and parity assignments made are $J^\pi = 5/2^+$ and $J^\pi = 1/2^+$ for the doublet at 5.3 MeV. The 6.3-MeV level is assigned $J^\pi = 3/2^-$. Of the triplet of levels at 7.3 MeV, only the 7.3- and 7.5-MeV levels are strongly excited. These agree with $J^\pi = 3/2^+$ and $J^\pi = 7/2^+$, respectively. (auth)

7818 PHOTONEUTRON CROSS SECTIONS FOR ^{138}Ba AND ^{14}N. Berman, B. L.; Fultz, S. C.; Caldwell, J. T.; Kelly, M. A.; Dietrich, S. S. (Univ. of California, Livermore). Phys. Rev., C; 2: 2318-23(Dec 1970).

Photoneutron cross sections, including $\sigma[(\gamma,n) + (\gamma,pn)]$, $\sigma(\gamma,2n)$, and $\sigma(\gamma,3n)$ for ^{138}Ba and $\sigma[(\gamma,n) + (\gamma,pn)]$ for ^{14}N, were measured with monoenergetic photons from threshold to 29 MeV. The partial cross sections were determined by neutron multiplicity counting, and the average neutron energies for both single- and double-photoneutron events were determined simultaneously with the cross-section data by the ring-ratio technique. The ^{14}N data, when combined with data from other laboratories, appear to show that the (γ,pn) process dominates the decay of the giant resonance in this nucleus. The giant-resonance parameters for ^{138}Ba are nearly the same as those for ^{141}Pr, which has the same (magic) neutron number. (auth)

7819 $^{12}C(\alpha,\gamma)^{16}O$ CAPTURE CROSS SECTION BELOW 4.1 MeV. Jaszczak, Ronald J.; Macklin, R. L. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 2: 2452-3(Dec 1970).

The possibility of 1^- states above the 9.58- and 7.12-MeV states in ^{16}O interfering with these lower states would strongly affect the $^{12}C(\alpha,\gamma)^{16}O$ capture cross sections near E_α = 3.2 MeV and the inferred stellar-reaction rate. Cross sections below 3.2 MeV reported earlier were extended to 4.1 MeV using similar techniques and overlap the previous measurement from ~2.9 to ~3.2 MeV. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 6549, 7158, 7484, 7800, 7806, 7808, 7812, 7845, 7847, and 7918.

7820 (N-70-28737) MUONIC INTERACTIONS ^{66}Zn AND ^{68}Zn. Jenkins, D. A.; Powers, R. J.; Kunselman, A. R. (Virginia Polytechnic Inst., Blacksburg). [1970]. 16p. (NASA-CR-110215). NTIS.

The charge radius of ^{68}Zn was measured, and the 2s-1s muonic energy difference was derived. ^{68}Zn was chosen because the energy of the 0^+ excitation is close to the energy difference of the 2s-1s mu-atomic levels; this allows a dynamic interaction between a muon in a 2s state and the nucleus in the ground state. It was found that the 2s-1s level difference is 20 keV less than the nuclear excitation energy and, as a result, the dynamic interaction is too small to observe. The 2p-1s X-ray energy in ^{66}Zn was measured, and the isotope shift in the muonic 2p-1s transition between ^{66}Zn and ^{68}Zn is reported. (auth) (STAR)

7821 MODEL FOR THE ^{28}Si SPECTRUM. Svenne, J. P. (Institut de Physique Nucleaire, Orsay, France). pp 867-71 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

A model is presented which explains all the levels of the ^{28}Si spectrum below 8 MeV. (auth)

7822 (α,p) REACTION ON $^{40,42,44,48}Ca$ AND ^{49}Ti AT 31 MeV. Ginaven, R. O.; Bernstein, Aron M. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys.; A154: 417-41(1970).

The (α,p) reaction was observed on $^{40,42,44,48}Ca$ and ^{49}Ti with 150 keV resolution at an incident energy of 31 MeV. From the negligible excitation of $d_{\frac{3}{2}}$ hole states and from the angular distributions and relative cross sections for ground state transitions in the $1f_{\frac{7}{2}}$ shell, the reaction mechanism is shown to be stripping. A gap of approximately 2.5 to 3 MeV in the proton spectra was observed to occur for nuclei towards the end of the $1f_{\frac{7}{2}}$ shell (^{47}Sc and ^{51}V) and is given a qualitative explanation. This gap ends with the onset of $p_{\frac{3}{2}}$ strength. Strong J-dependence is observed and enables us to distinguish between $p_{\frac{3}{2}}$ and $p_{\frac{1}{2}}$ transitions. This J-dependence is calculable by the distorted wave Born approximation (DWBA). Three L = 5 transitions were observed. These high-spin states have not been previously identified. The systematic behavior for transitions of each L and the good agreement with zero-range DWBA calculations based on a three-nucleon transfer mechanism enable one to make spin assignments. This was particularly valuable in the case of ^{51}Sc which is difficult to reach by other reactions. (auth)

7823 INVESTIGATION OF NUCLEAR LEVEL SPINS OF ^{56}Mn BY MEANS OF NUCLEAR ORIENTATION. Mellema, J.; Postma, H. (Kamerlingh Onnes Laboratorium, Leiden). Nucl. Phys.; A154: 385-406(1970).

High-energy gamma rays from thermal neutron capture in ^{55}Mn were investigated with a Ge(Li) detector. The Q-value for the $^{55}Mn(n,\gamma)^{56}Mn$ reaction was determined as 7270.2 ± 0.6 keV. Intensities of gamma rays following thermal neutron capture in ^{55}Mn nuclei were measured in two cases: with oriented spins and with isotropically distributed nuclear spins. The manganese nuclei were oriented in single crystal samples of $La_2Mn_3(NO_3)_{12} \cdot 24D_2O$ and $MnSiF_6 \cdot 6H_2O$, both at 0.056 ± 0.003 K. The samples were cooled with the aid of a $^3He-^4He$ dilution refrigerator. From the anisotropies of high- and low-energy gamma rays spin restrictions of many levels were deduced. The spins of the 1165- and 2202-keV levels turned out to be 1. For several low-energy transitions electromagnetic mixing ratios could be derived. (auth)

7824 DECAY OF ^{71m}Ge AND ^{71}As LEVEL SPECTRUM. Imanishi, N.; Nishi, T. (Kyoto Univ.). Nucl. Phys.; A154: 321-30 (1970).

The radioactive decay of ^{71m}Ge ($J^\pi = 1/2^-$, $T_{\frac{1}{2}}$ = 55.5 s) and ^{71}Ge ($J^\pi = 1/2^+$, $T_{\frac{1}{2}}$ = 11.3 h) was studied with the aid of Ge(Li) detectors. γ-ray spectrum measurements on the ^{71m}Ge decay and coincidence data on ^{71}Ge decay suggest that the first excited level of ^{71}As is at 194.5 keV. A tentative spin assignment of this level is made from the similarity of the low-energy level spectra and log ft values among the ^{73}As, ^{71}As and ^{79}Br nuclei. A few minor changes in the previous ^{71}Ge decay scheme are also proposed. The experimental level spectrum of ^{71}As is compared with theoretical predictions. (auth)

7825 NUCLEAR STRUCTURE INFORMATION FROM ISOVECTOR ELECTROMAGNETIC TRANSITIONS IN ^{51}V. Osnes, E. (NORDITA, Copenhagen); Warke, C. S. Nucl. Phys.; A154: 331-52(1970).

Isovector E2 and M1 transitions from the ^{51}V analog of the ^{51}Ti ground state are calculated with shell-model wave functions derived by Pellegrini and by Auerbach using empirical interaction matrix elements. On the whole, the calculated transition rates agree fairly well with those recently measured by the Copenhagen group. In order to obtain detailed agreement, it is necessary to include additional configurations in the parent analog state and consider admixtures from Gamow-Teller collective states in the final states. Of the two possible solutions for the mixing ratio δ(E2/M1) in the transition to the first $3/2^-$ level, the smaller one is strongly favored. (auth)

7826 ROLE OF ISOSPIN IN SHELL-MODEL CALCULATIONS OF N equals 28 NUCLEI. Osnes, E. (Univ. of Oslo). Nucl. Phys.; A154: 353-7(1970).

The shell-model description of N = 28 nuclei within the two lowest configurations is considered. The lowest configuration only involves proton–proton effective interactions, whereas the excited one involves proton–proton interactions and, if isospin is properly treated, also proton–neutron effective interactions. Thus, the two-nucleon matrix elements entering the description of the N = 28 nuclei also uniquely describe the N = 29 nuclei in their lowest configuration, and can therefore be obtained empirically by a fit to N = 28 and N = 29 spectra. It is shown that under certain circumstances the neglect of isospin in the excited configuration may not affect the energy level calculation seriously. (auth)

7827 (^{3}He,t) CHARGE EXCHANGE REACTION ON TARGETS OF ^{26}Mg AND ^{30}Si. Curtis, T. H.; Lutz, H. F.; Heikkinen, D. W.; Bartolini, W. (Univ. of California, Livermore). Nucl. Phys.; A154: 293-302(1970).

The charge exchange reactions ^{26}Mg(^{3}He,t)^{26}Al and ^{30}Si(^{3}He,t)^{30}P were studied at 17.85 MeV bombarding energy. Angular distributions were obtained for transitions leading to levels up to 2547 keV in ^{26}Al and 3020 keV in ^{30}P. The 1760 keV level of ^{26}Al was not excited. The data are analyzed with a microscopic model DWBA code that included a tensor force in addition to the central forces. The inclusion of the tensor part of the interaction permits fitting the non-analog transitions. (auth)

7828 STUDY OF (n,2p) REACTIONS AT 14 MeV. Lulic, S.; Strohal, P.; Slaus, I. (Inst. Ruder Boskovic, Zagreb). Nucl. Phys.; A154: 273-82(1970).

The (n,2p) reaction cross section was measured at E_n = 14.6 MeV for ^{45}Sc, ^{51}V, ^{75}As, ^{89}Y, ^{93}Nb, ^{133}Cs and ^{139}La, and the following values were obtained: 25 ± 10 μb, ≈60 μb, 52 ± 29 μb, 50 ± 40 μb, 50 ± 20 μb, 25 ± 20 μb and 30 ± 20 μb. In previous measurements, mainly upper limits were obtained. The (n,2p) reaction cross sections were compared with the (n,pn) cross section using a simple model. (auth)

7829 RADIATIVE NEUTRON CAPTURE ON Si, Rb, Sr, AND Y IN THE DIPOLE GIANT RESONANCE REGION. Rigaud, F.; Roturier, J.; Irigaray, J. L.; (and others) (CEN, Bordeaux-Gradignan, France). Nucl. Phys.; A154: 243-60(1970).

Gamma-ray spectra from the radiative capture of 14.06 MeV neutrons in natural Si, Rb, Sr and Y are investigated. The time-of-flight method is used to discriminate photons from scattered neutrons and to obtain about a 20 keV energy spread of incident neutrons. These results are compared with the theoretical predictions of direct and collective capture mechanisms, including the contribution of the interference between them. The agreement between theory and experiment seems satisfactory, though for the ^{28}Si(n,γ) reaction a contribution from the compound nucleus mechanism can be of importance. The integrated cross sections for Si, Rb, Sr and Y are 640 ± 165 μb, 770 ± 230 μb, 1970 ± 580 μb, and 1020 ± 280 μb, respectively. (auth)

7830 M1 AND E2 TRANSITIONS FROM 1^+ AND 3^+ STATES IN EVEN-A NICKEL ISOTOPES. Rustgi, M. L.; Roy, B. Barman; Raj, R. (State Univ. of New York, Buffalo). Phys. Rev., C; 2: 2446-8(Dec 1970).

More information on B(M1) and B(E2) values for 1^+ and 3^+ states in even nickel isotopes is made available. Results of calculations carried out with the Tabakin reaction matrix elements are also reported. The calculations are performed within the framework of the modified Tamm–Dancoff approximation. (auth)

7831 INTRINSIC QUADRUPOLE-MOMENT TRANSITION RATES AND SPECTROSCOPIC FACTORS FOR THE SELF-CONSISTENT HFB SHAPES OF THE Ti, Cr, AND Fe ISOTOPES. Chandra, Harish (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., C; 2: 2444-6(Dec 1970).

Intrinsic quadrupole moments for the self-consistent deformed Hartree–Fock–Bogoliubov (HFB) shapes for the even Ti, Cr, and Fe isotopes are calculated and compared with results obtained from the self-consistent Hartree–Fock (HF) approximation. It is pointed out that in the HFB approximation for even Z < N = 28 nuclei one gets spherical shapes, and hence to calculate the B(E_2) rates it is not proper to use the deformed HF wave functions. The B(E_2) rates were calculated with the excited-state wave functions constructed over the spherical BCS solutions in the random-phase approximation. (auth)

7832 DECAY OF ^{81}Rb. Waters, S. L. (Hammersmith Hospital, London); Silvester, D. J.; Goodier, I. W. Phys. Rev., C; 2: 2441-3(Dec 1970).

The energies and relative intensities of γ rays emitted in the decay of ^{81}Rb were measured for mass-separated sources using a 15-cm^3 Ge(Li) detector. New weak-intensity γ-rays were observed at 244, 1041, 1069, 1109, 1429, and 1555 keV. The half-life of ^{81}Rb was measured as 4.580 ± 0.009 h. (auth)

7833 BETA DECAY AS A TEST OF THE ^{88}Sr 3^- WAVE FUNCTION. Beres, William P.; Dorenbusch, William E. (Wayne State Univ., Detroit). Phys. Rev., C; 2: 2453-4(Dec 1970).

Allowed $\Delta T = 1$ Gamow–Teller β decay from the ^{88}Rb 2^- ground state to the ^{88}Sr 3^- level at 2.73 MeV is calculated. A one-particle–one-hole description of the latter state requires the $[2p^{-1}(n)2d_{\frac{5}{2}}(n)]^{\frac{1}{2}-\frac{3}{2}}_{T=1}$ component in order to predict the observed log ft value of 6.7. The decay rate is extremely sensitive to the amplitude of this term. (auth)

7834 STUDY OF THE ^{33}Cl(β^+)^{33}S DECAY. Bardin, T. T.; Becker, J. A.; McDonald, R. E.; Jones, A. D. W. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Phys. Rev., C; 2: 2283-8(Dec 1970).

Delayed γ radiation with $t_{\frac{1}{2}}$ = 2.5 sec produced in the ^{32}S(d,n)^{33}Cl reaction was detected with a Ge(Li) γ-ray spectrometer. From the observed γ-ray spectrum, β branches to the 2.87-MeV level, the 1.97-MeV level, the 0.84-MeV level, and the ground state of ^{33}S were deduced. The β branching ratios and log ft values are, respectively, [(0.56 ± 0.06)%; 4.05 ± 0.05], [(0.56 ± 0.06)%; 4.87 ± 0.05], [(0.54 ± 0.10)%; 5.59 ± 0.08], and [(98.3 ± 0.2)%; 3.74 ± 0.01] for these decays. The branches to the 1.97- and 0.84-MeV levels are reported for the first time. The measured energies of these excited states are 2866.5 ± 0.5, 1966.1 ± 0.6, and 840.5 ± 1.0 keV. The comparison with theory is discussed. The decay ^{25}Al(β^+)^{25}Mg was also studied. (auth)

7835 LIFETIMES OF EXCITED LEVELS AND ELECTROMAGNETIC TRANSITION RATES IN ^{51}V, ^{75}As, ^{90}Y, AND ^{123}Sb. Singh, H.; Sethi, B.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., C; 2: 2278-82(Dec 1970).

The lifetimes of the excited states in ^{51}V, ^{75}As, ^{90}Y, and ^{123}Sb were measured by the delayed-coincidence technique using a time-to-amplitude converter. The results are $T_{\frac{1}{2}}$(319.5 keV, ^{51}V) = 0.190 ± 0.030 nsec, $T_{\frac{1}{2}}$(927.5 keV, ^{51}V) = 0.070 ± 0.025 nsec, $T_{\frac{1}{2}}$(198.0 keV, ^{75}As) = 0.75 ± 0.15 nsec, $T_{\frac{1}{2}}$(202.7 keV, ^{90}Y) = 0.180 ± 0.030 nsec, $T_{\frac{1}{2}}$(160.2 keV, ^{123}Sb) = 0.60 ± 0.08 nsec. The energies and relative intensities of the γ rays in these nuclei were determined with the help of a Ge(Li) detector. On the basis of these measurements and the values of multipole mixing ratios, the reduced B(M1) and B(E2) transition probabilities were deduced for various transitions in these nuclei. The hindrance and enhancement factors are determined with respect to the Weisskopf single-particle estimates for M1 and E2 transitions, respectively. (auth)

7836 ENERGY LEVELS IN ^{86}Sr FROM THE DECAY OF 14.6-h ^{86}Y. Ramayya, A. V. (Vanderbilt Univ., Nashville); Van Nooijen, B.; Ford, J. W.; (and others). Phys. Rev., C; 2: 2248-78(Dec 1970).

The radioactive decay of ^{86}Y was investigated by performing internal- and external-conversion measurements with an iron-free double-focusing β-ray spectrometer, γ-ray measurements with Ge(Li) spectrometers, and γ-γ coincidence experiments with NaI-NaI, NaI-Ge(Li), and Ge(Li)-Ge(Li) coincidence arrangements coupled to two-parameter analyzers. Coincidence relationships were used extensively to aid in the construction of a level scheme for ^{86}Sr. Excited states are established at 1076.63, 1854.20, 2229.68, 2481.91, 2642.27, 2672.76, 2788.2, 2878.28, 2997.34, 3055.66, 3185.19, 3291.08, 3317.58, 3362.06, 3499.84, 3555.71, 3644.94, 3686.74, 3765.59, 3774.80, 3831.06, 3871.53, 3925.89, 3942.41, 3968.84, 4146.0, 4206.00, 4339, 4410.5, 4718, and 4954 keV. The K conversion coefficient was directly measured for the 1076.63-keV transition and this transition was used to obtain K conversion coefficients from the relative γ-ray intensities and the relative conversion-electron intensities. A new decay scheme is proposed which removes the inconsistencies of the older scheme and gives a much more detailed picture of the decay properties of the ^{86}Y nucleus. (auth)

7837 E2 TRANSITION STRENGTHS BETWEEN $(1f_{\frac{7}{2}})^{\pm 2}$ STATES OF ^{42}Ca, ^{50}Ti, AND ^{54}Fe. Cochavi, S. (State Univ. of New York, Stony Brook); Fossan, D. B.; Henson, S. H.; Alburger, D. E.; Warburton, E. K. Phys. Rev., C; 2: 2241-8(Dec 1970).

The lifetimes of the 6^+ states at 3.20 MeV in ^{50}Ti and 2.95 MeV in ^{54}Fe were measured by a β-γ delayed-coincidence technique using accelerator-produced 1.72-min ^{50}Sc and 1.5-min ^{54}Co activities, respectively. Mean lifetimes of τ = 630 ± 30 psec for the 3.20-MeV state in ^{50}Ti and τ = 1.71 ± 0.04 nsec for the 2.95-MeV state in ^{54}Fe were obtained. The 4^+ 2.75-MeV state in ^{42}Ca was determined to have a mean lifetime of τ = 11.5 ± 2.5 psec by a recoil-distance measurement with the ^{39}K(α,p)^{42}Ca reaction. The

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resulting $6^+ \rightarrow 4^+$ and $4^+ \rightarrow 2^+$ E2 transition strengths are compared with Coulomb-excitation $2^+ \rightarrow 0^+$ results and theoretical predictions. The E2 strengths in ^{50}Ti and ^{54}Fe are consistent with $(1f_{\frac{7}{2}})^{\pm 2}$ configurations for the 0^+, 2^+, 4^+, and 6^+ group of states, and do not indicate deformed-core components such as are required in the lower members of the ^{42}Ca group. (auth)

7838 GAMMA-RAY DECAY OF THE LOW-LYING LEVELS OF ^{21}F. Warburton, E. K.; Olness, J. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 2: 2235-40(Dec 1970).

The ^{19}F(t,pγ)^{21}F reaction at triton energies near 3 MeV was used to study the γ-ray decay of the first six energy levels of ^{21}F. γ-ray decay modes and Doppler-shift information was obtained from proton-γ coincidence measurements. Some excitation energies were obtained from singles measurements, as well as the coincidence studies. Excitation energies (in keV) and lifetimes (in psec) for the first six levels are 279.92 ± 0.06, 8800 ± 330; 1100.9 ± 2.0, 0.44 ± 0.08; 1729.6 ± 1.0, 0.07 ± 0.06; 1754.9 ± 0.7, >1.5; 2040.0 ± 2.0, <0.05; and 2070.9 ± 2.0, 0.08 ± 0.03. Some information was also obtained on the γ-ray branching of higher states. (auth)

7839 ^{88}Sr(p,n)^{88}Y REACTION IN THE PROTON ENERGY RANGE FROM 4.4 TO 8.0 MeV. Gabbard, F. (Univ. of Texas, Austin); Bonner, T. I.; Proffitt, R.; Schrils, R. Phys. Rev., C; 2: 2227-35(Dec 1970).

The ^{88}Sr(p,n)^{88}Y reaction cross section was measured in the proton bombarding energy range between the (p,n) threshold and 8.0 MeV. The neutron detector was a 24-in. cube of polyethylene with four ^{3}He neutron counters inserted radially toward the center of the cube where the target of ^{88}SrO was placed. Analysis of the data was carried out by means of direct solution of the Lane equations and by application of a method similar to that due to Robson. In both analyses, the calculated excitation functions were compared with the (p,p) and (p,n) data. It is shown, in a practical sense, that the two methods of analysis give essentially equivalent results. (auth)

7840 STUDY OF THE ENERGY LEVELS OF ^{74}Ge USING NUCLEAR PHOTOEXCITATION. Moreh, R.; Shahal, O. (Nuclear Research Centre, Beer Sheva, Israel). Phys. Rev., C; 2: 2217-26(Dec 1970).

Elastic and inelastic scattering of monochromatic photons were used for studying the energy levels of ^{74}Ge; the photons were produced by thermal-neutron capture in iron. The energy of the resonance level was found to be 6.018 MeV. Assuming the high-energy lines to be primary transitions de-exciting the resonance level, eight energy levels were found from the ground state up to 3 MeV, four of which are believed to be new levels in ^{74}Ge. The angular distribution of the elastic and inelastic lines were measured and the following spin-parity determinations were made: 0.596(2^+), 1.206(2^+), 1.486(0^+), 2.200(2^+), 2.229(0^+), and 6.018(1^-). The parities of the first and last levels were directly determined by polarization measurements using a Compton polarimeter. The parities of the other levels were inferred from the radiation strengths of the corresponding high-energy transitions. The total and partial radiative widths of the 6.018-MeV level were also measured. The M2/E1 mixing ratios for the high-energy transitions were obtained. For one transition, this ratio was $\chi^2 = 0.017$, which is much higher than that predicted by the simple theory. (auth)

7841 ^{58}Ni(p,^{3}He)^{56}Co AND (p,t)^{56}Ni REACTIONS AT 45 MeV. Bruge, G.; Leonard, R. F. (Univ. of California, Berkeley). Phys. Rev., C; 2: 2200-17(Dec 1970).

The reactions ^{58}Ni(p,^{3}He) and ^{58}Ni(p,t) were studied at a proton energy of 45 MeV. An average energy resolution of 45 keV was achieved. Angular distributions were obtained for 26 levels of ^{56}Co and 20 states of ^{56}Ni. The experimental results were compared with distorted-wave Born-approximation calculations, using spectroscopic amplitudes given by a microscopic calculation. (auth)

7842 STUDY OF NUCLEAR STATES IN ^{40}Ca BY INELASTIC ELECTRON SCATTERING. Itoh, K.; Oyamada, M.; Torizuka, Y. (Tohoku Univ., Sendai). Phys. Rev., C; 2: 2181-99(Dec 1970).

High-resolution measurements of the differential cross sections for inelastic electron scattering of 183- and 250-MeV electrons by ^{40}Ca were carried out. Peaks were found with the following excitation energies (in MeV), and spins and parities: 3.74(3^-), 3.90(2^+), 4.49(5^-), 5.25(2^+), 5.61(2^+), 5.90(1^-), 6.29(3^-), 6.59(3^-), 6.95(1^-), 7.9(2^+,4^+), 8.5(2^+,4^+,5^-), and others in the giant-resonance region. The cross sections for these states were obtained in the momentum transfer range from 0.5 to 2.2 F^{-1}. The data of the 3^- and 5^- states were compared not only with Tassie's vibrational model, but also with the particle-hole model of Gillet et al. The excitations of the dipole states (T = 0) are compared with Fujii's calculation. The data were analyzed by using a distorted-wave code of Tuan, Wright, and Onley to extract the values of the reduced transition probabilities using the transition charge densities ρ_{tr} modified from the Tassie model, and from the particle-hole model. Then, the values of B(EL) obtained from the quite different models are compared. The shapes of ρ_{tr} which provide best fits to the data are presented. (auth)

7843 DECAY OF THE 6.1-MIN ^{82}Br ISOMER TO LEVELS IN ^{82}Kr. Raman, Subramanian (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 2: 2176-80(Dec 1970).

By comparing the Ge(Li) spectra from ^{82g}Br + ^{82m}Br sources with those from 35.5-h ^{82g}Br sources, seven γ rays were assigned to ^{82}Kr from the decay of 6.1-min ^{82m}Br. The β^- decay of 2^- ^{82m}Br populates nonpreferentially (i.e., with nearly the same log ft values) excited states in ^{82}Kr at 776.5, 1474.8, 1956.5, 2547.3, and 2556.1 keV. (auth)

7844 LEVELS OF ^{61}Cu, ^{64}Cu, ^{67}Ga, AND ^{68}Ga EXCITED BY THE (p,n) REACTION. Bass, W. T.; Stelson, P. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 2: 2154-68(Dec 1970).

Neutron time-of-flight techniques were used to study the (p,n) reaction on the nuclei ^{61}Ni, ^{64}Ni, ^{67}Zn, and ^{68}Zn. The locations of excited states in the residual nuclei were measured with an energy resolution of about 10 keV. The absolute excitation energies are accurate to ±2 keV for low-lying states and to ±5 to 7 keV for the highest states (2 to 3 MeV excitation). The following results were obtained: ^{61}Cu, 17 levels (0 to 2.6 MeV); ^{64}Cu, 66 levels (0 to 2.75 MeV); ^{67}Ga, 57 levels (0 to 3.3 MeV); and ^{68}Ga, 32 levels (0 to 1.6 MeV). Comparisons with other information on these nuclei indicate that the (p,n) reaction is a very effective tool for locating all the levels. The relative intensities of the neutron groups displayed distinctive patterns. However, quantitative yields of a succession of closely spaced proton energies showed typically 30% fluctuations. To maintain good energy resolution and yet reduce the fluctuations many individual runs were averaged in order to have more meaningful comparisons with the Hauser–Feshbach predictions. Spin assignments were made to 10 to 20 levels in ^{64}Cu, ^{67}Ga, and ^{68}Ga. The results are generally consistent with other available information on spin parities. (auth)

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Refer also to abstracts 6380, 7800, 7806, 7808, 7828, 7835, 7884, and 7885.

7845 (AAEC/TM-549) FISSION PRODUCT CROSS SECTIONS. Cook, J. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jun 1970. 14p. Dep. NTIS (U. S. Sales Only).

Work at the A.A.E.C. on the evaluation of the major 188 fission-product cross sections for use in reactor burnup calculations is outlined. The thermal region was dealt with using measured data where available, and knowledge of the statistics of resonances where no measurements have been made. The statistical region was computed using the full statistical theory with partial waves up to D states, while the fast region was calculated using the Perey–Buck version of the optical model. A standard U.K.A.E.A. library is being prepared containing these data. (auth) (Australia)

7846 (CEA-N-1370) THE RATE OF DISINTEGRATION OF NUCLIDES PRODUCED BY THE THERMAL FISSION OF ^{235}U AND ^{239}Pu, AND BY THE FAST FISSION (E ~ 1 MeV) OF ^{235}U, ^{238}U, AND ^{239}Pu. Barre, Bertrand; de Tourreil, Roland (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1970. 32p. (In French). Dep. NTIS (U. S. Sales Only).

The total activity per second of the products from the thermal fission of ^{235}U and ^{239}Pu and the fast fission of ^{235}U, ^{238}U, and ^{239}Pu is given for several cooling times between 1 and (5×10^8) sec; the contributions of the principal active nuclei to this activity are also given. (auth) (France)

7847 (ORNL-4513) PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1969. Obenshain, Felix E. (ed.) (Oak Ridge National Lab., Tenn.). Jun 1970. Contract W-7405-eng-26. 155p. Dep. CFSTI.

AMERICIUM-239—fission of isomers of spontaneous, (E)
CADMIUM-116—energy levels from proton scattering and Coulomb excitation, (E)

CALCIUM-40—Brueckner theory calculations for, occupation probabilities in renormalization of
CALIFORNIUM-252—neutron fission of, mass distribution from, (T)
CARBON-12—Brueckner theory calculations for, occupation probabilities in renormalization of
DEUTERONS—reactions (d,n) with neon-20 at 3 to 6 MeV, (E)
—reactions (d,p) with rubidium-87 at 11 MeV, (E)
ERBIUM-166—electric quadrupole moments of 4+ and 2'+ states of, (E)
ERBIUM-168—electric quadrupole moments of 4+ and 2'+ states of, (E)
ERBIUM-170—electric quadrupole moments of 4+ and 2'+ states of, (E)
FISSION—dynamic model of asymetric
—barrier for, relation between spontaneous fission isomers and double, (T)
FLUORINE-19—energy levels of, extended model description of
GAMMA RADIATION—production by collisions of cosmic, radiation with interstellar or intergalactic matter and fields, (T)
HELIUM-4—Brueckner theory calculations for, occupation probabilities in renormalization of
IRON-57—Moessbauer spectra in Cobalt iron sulfides, (E)
LINEAR ACCELERATORS—development and operation of ORELA, 1969
MESONS (K^-)—absorption by heavy nuclei, neutron halo studies by, (E/T)
MESONS (π^+)—interactions with nucleons, Veneziano model for meson (ρ) production in
MOLYBDENUM-92—deuteron reactions (d,n) at 12 MeV, (E)
NEON-20—energy levels of, extended model description of
—proton reactions (p,γ) at 0.98 to 2.2 MeV, (E)
—deuteron reactions (d,n) at 3 to 6 MeV, (E)
NEUTRONS—reactions with oxygen-16 at 3.685 to 4.340 MeV, total cross sections for, (E)
—scattering by oxygen-16 at 1.833 to 3.4413 MeV, differential cross sections for, (E)
—transmission by tin-116 at 20 to 10,000 eV, (E)
—reactions with tellurium isotopes, s-wave strength functions for resonance, (E)
—reactions (n,f) with uranium-234 at 0.82 to 22.9 MeV, (E)
NICKEL ALLOYS—Ni–Pd—nickel-61 hyperfine interactions in, (E/T)
NICKEL-61—hyperfine interactions at, in nickel–palladium alloys, (E/T)
NIOBIUM-91—energy levels from zirconium-90 (d,n) reactions, (E)
NUCLEAR MODELS—fission barrier calculations in droplet, static
NUCLEI—binding energy of, validity of phenomenological renormalized Hartree–Fock theory for
—Brueckner theory calculations for closed major shell and j subshell
—meson (K^-) absorption by heavy neutron halo studies by, (E/T)
NUCLEONS—interactions with mesons (π^+), Veneziano model for meson (ρ) production in
ORNL RESEARCH REACTOR—beam-hole facilities at
OXYGEN-16—Brueckner theory calculations for, occupation probabilities in renormalization of
—alpha decay of 8.87-MeV state in, search for parity-forbidden, (E)
—neutron total cross section at 3.685 to 4.340 MeV, (E)
—neutron scattering at 1.833 to 3.4413 MeV, differential cross sections for, (E)
OXYGEN-17—energy levels from neutron scattering by oxygen-16
PLUTONIUM-237—fission of isomers of, spontaneous, (E)
PLUTONIUM-242—neutron fission of, mass distribution from, (T)
PROTONS—reactions (p,γ) with neon-20 at 0.98 to 2.2 MeV, (E)
—reactions (p,f) with thorium-232 at 8 to 13 MeV, mass and energy distributions in, (E)
RUBIDIUM-87—deuteron reactions (d,p) at 11 MeV, (E)
RUBIDIUM-88—energy levels from rubidium-87 (d,p) reactions, (E)
SILICON-28—Brueckner theory calculations for, occupation probabilities in renormalization of
SILVER-107—energy levels of, (E)
SILVER-109—energy levels of, (E)
SODIUM-21—energy levels from neon-20 (p,γ) and (d,n) reactions, (E)
SPECTROPHOTOMETERS—calibration of infrared
SULFUR-32—Brueckner theory calculations for, occupation probabilities in renormalization of
TECHNETIUM-93—energy levels from molybdenum-92 (d,n) reactions, (E)
TELLURIUM ISOTOPES—neutron reactions with, s-wave strength functions for resonance, (E)
THORIUM-232—proton fission at 8 to 13 MeV, mass and energy distributions in, (E)
TIN-116—neutron transmission at 20 to 10,000 eV, (E)
TUNGSTEN-186—electric quadrupole moments of 4+ and 2'+ states of, (E)
URANIUM-234—neutron fission at 0.82 to 22.9 MeV, energy correlation in, (E)
URANIUM-236—neutron fission of, mass distribution from, (T)
—fission of isomers of, spontaneous, (E)
URANIUM-238—fission of isomers of, spontaneous, (E)
VAN DE GRAAFF ACCELERATORS—development and operation at ORNL, 1969
YTTERBIUM-172—electric quadrupole moments of 4+ and 2'+ states of, (E)
YTTERBIUM-174—electric quadrupole moments of 4+ and 2'+ states of, (E)
YTTERBIUM-176—electric quadrupole moments of 4+ and 2'+ states of, (E)
ZIRCONIUM-90—deuteron reactions (d,n) at 12 MeV, (E)
(M.C.G.)

7848 (RD/B/N-1737) FISP 2: THE CURRENT VERSION OF THE FISP PROGRAM FOR FISSION PRODUCT INVENTORIES. Clarke, R. H.; Utting, R. E. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jul 1970. 20p. Dep. NTIS (U. S. Sales Only).

Details are presented of the new facilities which have been added to the FISP program. The additions are the following: the decay chains are extended to be up to 9 isotopes long, and the stable nuclides are included into the standard library; the stable nuclides can be activated and the daughters allowed to decay; multi-energy group γ spectra can be generated and β heating evaluated for the inventory; macroscopic absorption data are evaluated; and inventories are more easily evaluated in the case of a reactor startup after being shutdown. These additional facilities are explained and a complete input data specification is presented, together with examples of the output produced. (auth) (UK)

7849 (RLO-1759-23) FISSION STUDIES ON ELEMENTS BELOW POLONIUM. Progress Report, July 1, 1969–June 30, 1970. Neuzil, Edward F. (Western Washington State Coll., Bellingham). [1969]. Contract AT(45-1)-1759. 10p. Dep. CFSTI.

Research progress in fission studies on elements below polonium at Western Washington State College in the period July 1, 1969 to June 30, 1970 is reported. The effect of angular momentum on fission is being studied through fission reactions creating the same compound nucleus at the same excitation energy but induced by different particles. Some results for ^{207}Pb(α,f), ^{209}Bi(d,f), ^{197}Au(d,f) and ^{195}Pt(α,f) reactions are presented. In addition, some results for ^{181}Ta(α,f) reactions are given. (J.W.R.)

7850 (TID-3317(Suppl.2)) TRANSPLUTONIUM ELEMENTS. A Bibliography. Stuber, Charles E. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Oct 1970. 92p. Dep. NTIS.

This bibliography is the second supplement to the original TID-3317 and contains 557 citations and abstracts of the international literature dealing with the production, chemical, physical, and nuclear properties, and natural occurrence of the transplutonium elements. References are grouped by element and arranged chronologically within each group. A transactinide group is included for references dealing with elements $Z \geq 104$. A detailed subject index and an author index with titles are also included. (C.E.S.)

7851 (UCRL-19530) NUCLEAR CHEMISTRY DIVISION ANNUAL REPORT, 1969. Edelstein, Norman; Hendrie, David; Michel, Maynard (eds.) (California Univ., Berkeley. Lawrence Radiation Lab.). Jan 1970. Contract W-7405-eng-48. 411p. Dep. CFSTI.

Separate abstracts were prepared for the 13 sections included. (J.W.R.)

For abstracts of individual sections see: 6290, 6323, 6324, 6342, 6402, 6538, 6590, 7145, 7808, 7852–7854, and 7888.

7852 (UCRL-19530, pp 1-52) NUCLEAR SPECTROSCOPY AND RADIOACTIVITY. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

ACTINIUM-218—alpha decay of, half-life for, (E)
ACTINIUM-219—alpha decay of, half-life for, (E)
ASTATINE-213—alpha decay of, half-life for, (E)

XUM

CALIFORNIUM-251—alpha decay of, α, γ, and conversion electron spectra from, (E)
CURIUM-247—energy level scheme from californium-251 decay, (E)
FRANCIUM-215—alpha decay of, half-life for, (E)
FRANCIUM-216—alpha decay of, half-life for, (E)
FRANCIUM-217—alpha decay of, half-life for, (E)
LEAD-206—energy level of, lifetime of first-excited, (E)
—energy levels of, g-factor of 7^-, (E)
NEPTUNIUM-235—alpha decay of, α and γ spectra from, (E)
NOBELIUM-255—alpha decay of, α energies and intensities and hindrance factors for, (E)
NOBELIUM-257—alpha decay of, α energies and intensities and hindrance factors for, (E)
OSMIUM-172—energy-level transitions in, (E)
OSMIUM-174—energy-level transitions in, (E)
OSMIUM-176—energy-level transitions in, (E)
PROTACTINIUM-231—energy level scheme from neptunium-235 and thorium-231 decays, (E)
RADON-214—alpha decay of, half-life for, (E)
RADON-215—alpha decay of, half-life for, (E)
RADON-217—alpha decay of, half-life for, (E)
RADON-218—alpha decay of, half-life for, (E)
RUTHENIUM-96—energy level scheme from molybdenum-94 (α,2n) reactions, (E)
RUTHENIUM-97—energy level scheme from (α,xn) reactions, (E)
RUTHENIUM-99—energy level scheme from (α,xn) reactions, (E)
RUTHENIUM-101—energy level scheme from (α,xn) reactions, (E)
RUTHENIUM-102—energy level scheme from molybdenum-100 (α,2n) reactions, (E)
THORIUM-231—beta decay of, γ singles and coincidence spectra from, (E) (J.W.R.)

7853 (UCRL-19530, pp 163-89) FISSION. (California Univ., Berkeley. Lawrence Radiation Lab.).
From nuclear chemistry division annual report, 1969.
CURIUM-244—alpha reactions (α,2n) with, search for fission isomer excitation in, (E)
—proton reactions (p,2n) with, search for fission isomer excitation in, (E)
FISSION PRODUCTS—beta decay of, rate calculations for, (T)
—decay of short-lived, x-ray studies on, (E) (J.W.R.)

7854 (UCRL-19530, pp 221-37) HYPERFINE INTERACTIONS. (California Univ., Berkeley. Lawrence Radiation Lab.).
From nuclear chemistry division annual report, 1969.
FERROMAGNETIC MATERIALS—perturbed angular correlations in
IRIDIUM-194—beta decay of polarized, β and γ-ray angular distributions from, (E)
MOLECULES—rotational correlation time of macro-, measurement using perturbed gamma angular correlations
RHENIUM-186—beta decay of polarized, β and γ-ray angular distributions from, (E)
RHENIUM-188—beta decay of polarized, β and γ-ray angular distributions from, (E)

7855 MAGNETIC MOMENT OF THE 91-keV EXCITED STATE OF ^{147}Pm. Bauminger, E. R.; Froindlich, D.; Mustachi, A.; Ofer, S.; Perkal, M. (Hebrew Univ., Jerusalem). Phys. Lett.; 32B: 678-9(14 Sep 1970).

Recoilless absorption measurements of the 91-keV γ rays of ^{147}Pm, with a $^{147}NdAl_2$ source and a radioactive $^{147}Pm_2O_3$ absorber, yielded a value of 1.925 ± 0.004 for the ratio of the g factors of the 91-keV level and the ground state of ^{147}Pm. (auth)

7856 MAGNETIC HYPERFINE STRUCTURE OF MUONIC ATOMS. Johnson, John; Sorensen, Raymond A. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., C; 2: 102-9(Jul 1970).

Magnetic hyperfine structure in muonic x rays is calculated for several models of the nuclear magnetism and compared to experimental values for ^{115}In, ^{127}I, ^{133}Cs, ^{139}La, ^{141}Pr, ^{151}Eu, ^{203}Tl, ^{205}Tl, and ^{209}Bi. The results are excellent for the realistic models in most cases, and all but one of the nine cases agree within better than two standard deviations with the experiments. For the realistic models, the hyperfine energy is substantially reduced (by about 30% in most cases) from its point-nucleus value. In these models, the single-particle magnetism distribution is modified by the addition of configurations resulting from various residual nuclear interactions, the interaction strength being adjusted in each case to produce the experimental value for the magnetic moment. (auth)

7857 GROUND-STATE BANDS IN NEUTRON-RICH EVEN Te, Xe, Ba, Ce, Nd, AND Sm ISOTOPES PRODUCED IN THE FISSION OF ^{252}Cf. Wilhelmy, J. B.; Thompson, S. G.; Jared, R. C.; Cheifetz, E. (Univ. of California, Berkeley). Phys. Rev. Lett.; 25: 1122-5(19 Oct 1970).

Experimental results are presented on the ground-state bands of heavy even–even nuclei produced in the primary fission of ^{252}Cf. Experimental values for the energy levels and lifetimes range from those typical of spherical nuclei to those associated with permanently deformed nuclei. (auth)

7858 MOMENTS OF INERTIA AND THE ENERGY GAP PARAMETERS OF DEFORMED EVEN–EVEN NUCLEI IN RARE-EARTH REGION. Birbrair, B. L.; Nikolaev, K. N. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 32B: 672-4(14 Sep 1970).

The proton and neutron energy-gap parameters calculated from experimental values of moments of inertia and collective gyromagnetic ratios are found to be considerably less than those obtained from odd–even mass differences. (auth)

7859 OCTUPOLE STATES OF DEFORMED NUCLEI. Vogel, P. (Nuclear Research Inst., Rez, Czech.). pp 857-66 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The standard RPA calculation for octupole states in deformed nuclei is sketched. The results of several calculations for energies and transition probabilities using the octupole–octupole force and the surface-delta interaction are given and compared with experiment. The nuclear potential energy is calculated as a function of the octupole deformation parameter. The Coriolis interaction is also discussed as a possible reason for the discrepancy between theory and experiment. The interaction causes mixing between different bands and distortion of the rotational sequences. Although it does not completely resolve the discrepancies, the Coriolis interaction is seen to be important for understanding the remaining problems. (R.W.R.)

7860 ^{122,124}Sn(t,p)^{124,126}Sn REACTION AT 20 MeV. Flynn, E. R.; Berry, J. G.; Blair, A. G. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A154: 225-42 (1970).

The ^{122,124}Sn(t,p)^{124,126}Sn reaction was studied at an incident triton energy of 20 MeV. A large number of new levels are reported in both ^{124}Sn and ^{126}Sn, the majority of these being at excitation energies above 4.5 MeV. Distorted wave calculations are compared to the data with spins and spectroscopic information obtained. Several theoretical wave function sets for the tin isotopes are employed for the distorted wave form factor. Relatively large cross sections are seen for the levels above 4.5 MeV and these are interpreted as being of the particle-quasiparticle type. (auth)

7861 NUCLEAR GROUND STATE SPINS OF NEUTRON-DEFICIENT Dy ISOTOPES. Rosen, A.; Ekstroem, C.; Nyqvist, H.; Aedelroth, K. E. (Chalmers Univ. of Tech., Goteborg. Univ. of Goteborg). Nucl. Phys.; A154: 283-92(1970).

The atomic-beam magnetic resonance method was applied to measure the nuclear ground state spins of five neutron-deficient dysprosium isotopes with the following results: ^{151}Dy (18 min) $I = 7/2$, ^{152}Dy (2.4 h) $I = 0$, ^{153}Dy (6 h) $I = 7/2$, ^{155}Dy (10 h) $I = 3/2$ and ^{157}Dy (8.1 h) $I = 3/2$. The measured spin values are discussed in terms of the unified nuclear model and comparisons with results from spectroscopic measurements are made. (auth)

7862 INELASTIC SCATTERING OF DEUTERONS FROM ^{197}Au. Sharma, R. P. (Univ. of Copenhagen). Nucl. Phys.; A154: 312-20(1970).

The energy levels of ^{197}Au are studied by inelastic scattering of 12.1-MeV deuterons at 80, 95, 125, and 150°. These levels extend up to 2.6 MeV. The observed results are compared with the neighboring isotopes of ^{196}Pt and ^{198}Hg, and some similarities are indicated. The levels extending up to 735 keV in energy were also excited by Coulomb excitation with 52-MeV oxygen ions. The B(E2) values for the transitions to the first four excited states were obtained. (auth)

7863 DECAY PROPERTIES OF THE 99- AND 130-keV LEVELS IN ^{195}Pt. Ahlesten, B.; Baecklin, A. (Swedish Research Councils' Lab., Studsvik, Sweden). Nucl. Phys.; A154: 303-11(1970).

Energies and intensities of conversion electrons and gamma-rays from the decay of ^{195}Au were measured with a $\pi\sqrt{2}$ electron spectrometer and a Si(Li) detector. The 30.94-keV transition was

found to be M1 + (0.045 ± 0.015) % E2 and the 98.84-keV transition was found to be M1 + (1.77 ± 0.23) % E2. The corresponding B(E2) and B(M1) values are fitted into a systematic study of these quantities and compared to theoretical predictions. (auth)

7864 PERTURBED GAMMA-RAY ANGULAR DISTRIBUTION FROM Yb NUCLEI RECOILING IN VACUUM. Brenn, R.; Lehmann, L.; Spehl, H. (Univ., Freiburg i. B.). Nucl. Phys.; A154: 358-68(1970).

The attenuation of the γ-ray angular distribution of Coulomb excited Yb nuclei recoiling in vacuum was measured with a new time-differential technique. The perturbation mechanism due to the time-dependent hyperfine interaction in highly ionized and excited, free ions is discussed in terms of the Abragam and Pound and the Dillenburg and Maris theories. (auth)

7865 MAGNETIC MOMENT OF A SUGGESTED THREE-QUASIPARTICLE STATE IN ^{125}Te. Cruse, D. W.; Johansson, K.; Karlsson, E. (Univ. of Uppsala). Nucl. Phys.; A154: 369-84(1970).

The magnetic moments of the 321-keV $9/2^-$ and 464-keV $5/2^+$ levels of ^{125}Te were determined by the PAC method to be $\mu = -(0.918 \pm 0.032)$ n.m., and $\mu = -(0.58 \pm 0.27)$ n.m., respectively. The result for the 321-keV level agrees with the prediction of Kisslinger's three-quasiparticle model. The values of the angular correlation coefficients of the 321−177 keV and 204−177 keV cascades are, after correction for background coincidences and solid angle, $A_2 = -0.168 \pm 0.012$, $A_4 = -0.003 \pm 0.015$ and $A_2 = -0.403 \pm 0.014$, $A_4 = +0.003 \pm 0.020$ respectively. The mixing ratio for the 204-keV ($7/2^- - 5/2^-$) transition is $\delta(E2/M1) = -1.88 \pm 0.22$ giving an E2 content of $Q(E2) = 0.78 \pm 0.04$, while for the 321-keV ($7/2^+ - 5/2^-$) transition $0 \leq Q(M2) \leq 0.010$ and $-0.22 \leq \delta(M2/E1) \leq 0$. The magnetic hyperfine field for tellurium in gadolinium was measured with the result $B_{hf} = -38 \pm 10$ kG. The electric quadrupole interaction frequency of the 321-keV level for Te in Gd is $\omega_0^+ = (270 \pm 70) \cdot 10^6$ rad/s. (auth)

7866 NUCLEAR PROPERTIES OF ^{254}Md, ^{255}Md, ^{256}Md, ^{257}Md, AND ^{258}Md. Fields, P. R.; Ahmad, I.; Barnes, R. F.; Sjoblom, R. K.; Horwitz, E. P. (Argonne National Lab., Ill.). Nucl. Phys.; A154: 407-16(1970).

The isotopes $^{254-258}$Md were produced by irradiating an Es target with ^{4}He ions and their nuclear properties were investigated. A chromatographic separation procedure was utilized to obtain pure Md samples. The half-lives of ^{255}Md, ^{256}Md, ^{257}Md and ^{258}Md were found to be 27 ± 2 min, 75 ± 4 min, 5.4 ± 0.5 h and 56 ± 7 d, respectively, and are in agreement with previously reported values. The $\alpha/(\alpha + EC)$ ratios for ^{255}Md, ^{256}Md and ^{257}Md were measured to be 7 ± 1%, 8.5 ± 0.8% and 10 ± 3%, respectively. The main α groups of ^{255}Md, ^{256}Md, ^{257}Md and ^{258}Md were found to have energies of 7.322 ± 0.005, 7.202 ± 0.005, 7.064 ± 0.005 and 6.716 ± 0.005 MeV, respectively. The nuclide ^{254}Md was observed for the first time and was found to decay by EC with a half-life of 10 ± 3 min. Successive chemical separations of Fm indicate the existence of another ^{254}Md isomer having a half-life of 28 ± 8 min. (auth)

7867 FRAGMENTATION OF THE SINGLE-PARTICLE STRENGTH IN ^{209}Bi. Ellegaard, C.; Patnaik, B.; Barnes, P. D. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., C; 2: 2450-2 (Dec 1970).

The intense peak observed in the spectra of the ^{208}Pb(^{3}He,d)^{209}Bi reaction at an excitation energy of 4.42 MeV has given rise to two conflicting interpretations, neither of which has satisfactorily explained its intensity. In the present work a resolution of 16 keV was obtained for the (^{3}He,d) reaction and the peak was resolved and shown to be a doublet with the intensity ratio 3:1. A possible interpretation of this doublet is discussed. (auth)

7868 ALPHA-DECAY STUDIES OF THE N = 127 ISOTONES ^{214}Fr, ^{215}Ra, AND ^{216}Ac. Torgerson, David F.; Macfarlane, Ronald D. (Texas A and M Univ., College Station). Phys. Rev., C; 2: 2309-18(Dec 1970).

The study of nuclei which are one neutron removed from the N = 126 closed shell has shown that the odd-proton N = 127 isotones α decay from both the ground state and a metastable state whose excitation energy decreases between ^{210}Bi and ^{216}Ac. The α-decay daughters of these nuclei show some correspondence in their energy-level spacings which is due to the coupling of specific single-particle configurations near the N = 126 closed shell. New information was obtained for the α decay of the 1− isomer of ^{214}Fr to levels in ^{210}At, and for the α decay of ^{216}Ac to levels in ^{212}Fr. The decay scheme of ^{216}Ac is markedly different from that reported by others. An experimental and theoretical study of the α decay of ^{215}Ra was also made. (auth)

7869 NEUTRON SHELL STRUCTURE IN ^{91}Zr AND ^{92}Zr BY (d,p) AND (α,^{3}He) REACTIONS. Bingham, C. R. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Halbert, M. L. Phys. Rev., C; 2: 2297-2309(Dec 1970).

Angular distributions from ~12.5 to ~45° were measured for ^{90}Zr(d,p) and ^{91}Zr(d,p) at 33.3 MeV. The resolution was about 25 keV. A number of doublets were resolved, and levels were found that had not been reported in previous neutron-transfer studies. ^{90}Zr(α,^{3}He) and ^{91}Zr(α,^{3}He) spectra with 55-keV resolution were obtained at 15 and 20° with 65.9-MeV α particles. The data are compared with distorted-wave predictions. The (d,p) spectroscopic factors agree with those from the (α,^{3}He) reaction wherever comparisons are feasible. Sums of spectroscopic factors, centers of gravity, and second moments are presented for levels assigned to $d_{5/2}$, $s_{1/2}$, $d_{3/2}$, $g_{7/2}$, and $h_{11/2}$ configurations in each final nucleus. The sums are generally in agreement with the sum-rule predictions. The $h_{11/2}$ strength appears to be highly fragmented; in both nuclei, about 50% of the predicted strength was identified. The separations of the centers of gravity are similar for the two nuclei. (auth)

7870 FISSION OF ^{233}U WITH 14.8-MeV NEUTRONS. Nethaway, D. R.; Mendoza, B. (Univ. of California, Livermore). Phys. Rev., C; 2: 2289-96(Dec 1970).

The yields of 25 products in the mass range from 66 to 175 from fission of ^{233}U with 14.8-MeV neutrons were measured. Each fission yield was measured in an absolute way, the number of atoms formed of each product being measured by absolute β- and γ-counting techniques. The number of fissions occurring was calculated from the target mass, the fission cross section, and the total neutron fluence. The neutron fluence in the target was monitored by the (n,2n) reaction on yttrium foils. Total chain yields were estimated by correcting for the effects of nuclear charge dispersion in fission. The contribution of target-impurity activation to the measured fission yields is generally small. The yields of products on the wings of the mass-yield distribution are consistent with a Gaussian function, which is similar to those found previously for ^{235}U and ^{238}U fission. The yields of a number of unmeasured products on the wings were estimated and tabulated using the Gaussian curve. The yields of a sufficient number of products in the peak and valley regions were measured so that a rough outline of the high-yield portion of the mass distribution could be made. The area under each half of the mass-yield curve was about 1.08, or 8% high. This discrepancy may be due to insufficient knowledge of the mass-yield curve, the contribution of fission induced by non-14.8-MeV neutrons, and/or errors in the cross sections that were used for the monitor reaction and the ^{233}U fission reaction. A very low peak-to-valley ratio of about 3.1 was observed, which is smaller than found for fission of other nuclides with 14.8-MeV neutrons. The yields in the valley region are about 70% higher than those measured previously by others. This is probably due to the contribution of low-energy neutron fission in the earlier work, coupled with their normalization to unit fragment yield. A thermal-neutron contaminant of 0.3% in the target region could have caused the observed discrepancy. The fission yield of the shielded product ^{160}Tb was measured as $(3.2 \pm 0.8) \times 10^{-7}$. Using the total chain yield for mass 160 calculated from our Gaussian distribution function, we obtain $(4.3 \pm 1.2) \times 10^{-3}$ for the independent fractional chain yield. This value was used to estimate the Z_p function for ^{233}U fission in order to calculate total chain yields from observed fission yields. (auth)

7871 STATES IN ODD-ODD ^{200}Tl POPULATED BY THE ELECTRON-CAPTURE DECAY OF ^{200}Pb. Doebler, R. E.; McHarris, Wm. C.; Kelly, W. H. (Michigan State Univ., East Lansing). Phys. Rev., C; 2: 2422-38(Dec 1970).

Low-spin states in ^{200}Tl were studied via the decay of 21.5-h ^{200}Pb, which was prepared by the reactions, ^{203}Tl(p,4n)^{200}Pb, ^{202}Hg(τ,5n)^{200}Pb, and ^{203}Tl(τ,6n)^{200}Bi → ^{200}Pb. Its γ rays were studied in singles, coincidence, anticoincidence, and Ge(Li)-Ge(Li) two-dimensional (2048 × 2048 channel) coincidence experiments. Nineteen γ transitions were assigned to the decay of ^{200}Pb, and all have been placed in a consistent level scheme, states in ^{200}Tl populated by ^{200}Pb decay lie at 0 ($I\pi = 2-$), 147.63 (0−), 257.19 (1−), 289.24 (2−, 1−), 289.92 (1−), 450.56 (1−), 525.54 (1−), and 605.44 keV (1−). The spin and parity assignments are based on measured conversion coefficients, relative photon intensities, and log ft values. The structures of the states are discussed in terms of the coupling of the possible single-particle states in adjacent odd-A nuclei. An upper limit of 1 sec is placed on the half-life of any possible isomeric state in ^{200}Pb itself. (auth)

7872 ISOMER SHIFTS OF THE FIRST AND SECOND EXCITED LEVELS OF THE GROUND-STATE ROTATIONAL BAND IN ^{171}Yb. Henning, W. (Argonne National Lab., Ill. Technical

Univ., Munich); Kalvius, G. M.; Shenoy, G. K. Phys. Rev., C; 2: 2414-21(Dec 1970).

The isomer shifts of the 66.7-keV $3/2^- \rightarrow 1/2^-$ and the 75.9-keV $5/2^- \rightarrow 1/2^-$ γ transitions of the 1/2[521] ground-state rotational band in ^{171}Yb were investigated, using the Moessbauer effect. From the observed shifts, the ratio of change in mean square charge radii for the two excited states was found to be $\Delta\langle r^2\rangle(76)/\Delta\langle r^2\rangle(67) = +0.42 \pm 0.20$. The decrease of $\Delta\langle r^2\rangle$ for higher rotational excitation is in disagreement with simple collective theory, and is discussed in terms of nonadiabatic effects. From the observed magnetic hyperfine splitting, the ratio of nuclear g factors was found to be $g(76)/g(0) = +0.411 \pm 0.002$. This value is in excellent agreement with an earlier measurement and is used, together with other recent data on all magnetic parameters of the 1/2[521] band, in discussing the spin polarizations effects. The mixing ratio δ^2 of the M1/E2, 66.7-keV γ transition in ^{171}Yb was redetermined correcting carefully for finite absorber effects. The new result is $\delta^2 = 0.36 \pm 0.04$. (auth)

7873 NEW ISOTOPE ^{150}Pr. Ward, T. E.; Marcos, N. A.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Phys. Rev., C; 2: 2410-13(Dec 1970).

Irradiation of enriched ^{150}Nd with fast neutrons was found to produce a new radioactivity which was assigned to the (n,p) product ^{150}Pr. The following radiation characteristics were observed to belong to ^{150}Pr: half-life 6.1 ± 0.3 sec, γ-ray energy 131.0 ± 0.8 keV, and maximum β^--ray energy 5.7 ± 0.3 MeV. (auth)

7874 INVESTIGATION OF THE REPORTED ^{103}Mo ISOMER. Takahashi, K.; Ward, T. E.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Phys. Rev., C; 2: 2408-10(Dec 1970).

A detailed radiochemical investigation of the previously reported 5.2-h ^{103}Mo fission isomer was performed. The evidence obtained indicates that the reported fission activity is a misassignment and is probably due to contamination. (auth)

7875 ALPHA DECAY OF ^{240}Am. Gorman, D. J.; Asaro, F. (Univ. of California, Berkeley). Phys. Rev., C; 2: 2406-8(Dec 1970).

Three α groups were observed in the decay of the odd-odd nucleus ^{240}Am with energies and relative abundances of 5.378 (86.8%), 5.337 (12.0%), and 5.286 (1.23%) MeV. The branching ratio for these three α groups is 1.9×10^{-4}%. The ground state of ^{240}Am has spin and K of 3, and odd parity. It is composed of proton and neutron quasiparticle states with Nilsson assignments ($K\pi[Nn_z\Lambda]$) of $5/2^-$ [523] and $1/2^+$ [631], respectively. The most abundant α group is nearly unhindered, and hence the state it populates in ^{236}Np has the same configuration as the parent. (auth)

7876 DISCONTINUITY IN ISOTOPIC MASS DISPERSION IN THERMAL-NEUTRON-INDUCED FISSION OF ^{235}U. Talat-Erben, M.; Dagsoez, Binay (Technical Univ., Istanbul). Phys. Rev., C; 2: 2403-5(Dec 1970).

The isotopic mass dispersion curves were calculated by using a universal isobaric-charge dispersion function and the revised fission yield data for individual nuclides reported by Wahl et al. The mass dispersion curves are discontinuous at the most probable fragment mass value, so that a different dispersion curve applies on either side of the most probable mass, both branches being Gaussian, except at Z = 50 where the dispersion law deviates from the Gaussian in the region of mass numbers larger than the most probable mass. For some Z values the dispersion is narrower on the light side and broader on the heavy side of the most probable mass, whereas the situation is the opposite for other Z values, without apparent regularity. For a very few Z values only, the two branches differ so little that they may practically be considered as defining a single curve. (auth)

7877 NEUTRON INELASTIC SCATTERING FROM ^{92}Zr AND ^{94}Zr. Tessler, G.; Glickstein, S. S.; Carroll, E. E. Jr. (Bettis Atomic Power Lab., West Mifflin, Pa.). Phys. Rev., C; 2: 2390-2402(Dec 1970).

Excitation functions for γ-ray emission and cascade γ-ray emission following neutron inelastic scattering from the 0.93-, 1.39-, 1.50-, 1.84-, 2.05-, and 2.33-MeV levels of ^{92}Zr and the 0.913-, 1.30-, 1.66-, 2.06-, 2.16-, and 2.36-MeV levels of ^{94}Zr have been measured for neutrons in the energy range 0.9 to 2.69 MeV. Cascade γ rays were detected with a sum-coincidence spectrometer consisting of two 3-in.-dia by 3-in.-long NaI(Tl) crystals each at 90° to the incident neutron beam direction. Crossover γ rays and individual components of cascades were measured with a 4-cm^3 planar Ge(Li) detector. Multiple-scattering and beam-attenuation corrections were calculated analytically. Angular-correlation functions for the cascade γ rays and angular distributions for the individual γ rays were calculated and used to deduce total neutron inelastic scattering cross sections. These cross sections are in agreement with values calculated from Hauser–Feshbach theory corrected for level-width fluctuations and with previous measurements. The data support the tentative J^π assignments of 2^+ and 4^+ for the 2.32- and 2.36-MeV levels of ^{94}Zr, respectively, which resulted from recent (p,p′) measurements. (auth)

7878 NUCLEAR ORIENTATION OF ^{253}Es IN NEODYMIUM ETHYLSULFATE. Soinski, A. J.; Frankel, R. B.; Navarro, Q. O.; Shirley, D. A. (Univ. of California, Berkeley). Phys. Rev., C; 2: 2379-90(Dec 1970).

Einsteinium-253 nuclei were oriented at low temperatures in a neodymium ethylsulfate lattice. From the temperature-dependent α-particle angular distribution a nuclear magnetic moment $|\mu| = (2.7 \pm 1.3)\mu_N$ was deduced. From the values for the angular distribution function at the lowest temperatures it was possible to test the predictions of the Mang shell-model theory for the relative phases and amplitudes of the α-partial waves. As predicted, the waves of angular momentum L = 0 and 2 are in phase, and the L = 0 and 4 waves are out of phase. The predicted wave amplitudes are in error, especially that of the L = 4 wave. The predicted relative intensities (which are proportional to the amplitudes squared) for the S, D, and G waves are 1.000 : 0.179 : 0.0052, whereas the relative intensities that best fit the experimental angular distribution are 1.000 : 0.216 : 0.0078. (auth)

7879 STUDIES OF THE RADIOACTIVE DECAYS OF ^{152}Eu AND ^{154}Eu. Riedinger, L. L. (Oak Ridge National Lab., Tenn.); Johnson, Noah R.; Hamilton, J. H. Phys. Rev., C; 2: 2358-79 (Dec 1970).

The γ rays emitted in the radioactive decays of ^{152}Eu and ^{154}Eu were studied with Ge(Li) and NaI detectors. Energies and relative intensities were derived from single experiments with large volume Ge(Li) detectors and assignments of γ rays to transitions in the level schemes were made with the help of Ge(Li)-NaI coincidence measurements. In all, 71 γ rays were observed in the ^{152}Eu decay and 51 in the ^{154}Eu case. Three members of each of the β- and γ-vibrational bands were observed. In addition the results of the coincidence experiments were used to assign a level at 1649.8 keV as the probable 2^- member of the K = 2 band in ^{152}Sm. The properties of this state and of the $K^\pi = 0^-$ and 1^- bands are compared with the properties of the corresponding states in ^{154}Gd. It is found that there is evidently less Coriolis coupling between the negative-parity states in ^{152}Sm than in ^{154}Gd. The members of the $K^\pi = 1^-$ band in the former are not inverted as in the latter, and the B(E1) ratios from the $K^\pi = 0^-$ states in the former are in better agreement with the predictions of the rotational model. The low-energy levels in ^{152}Gd are considered in light of two possible interpretations. It was found that it is preferable to consider these states as resulting from quasirotations and quasivibrations than to treat them as members of one-, two-, and three-phonon vibrational excitations about spherical equilibrium shapes. Finally, a new 2^+ level at 1293 keV in ^{152}Sm is discussed in light of recent experiments involving two-neutron-transfer reactions to levels in this nucleus. (auth)

7880 FISSION STUDIES OF THORIUM, URANIUM, AND PLUTONIUM ISOTOPES WITH (t,pf) REACTIONS. Cramer, J. D.; Britt, H. C. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 2: 2350-8(Dec 1970).

Experimental results are reported on fission probabilities and fragment angular correlations for (t,pf) reactions on ^{230}Th, ^{232}Th, ^{234}U, ^{236}U, ^{238}U, ^{238}Pu, ^{240}Pu, and ^{242}Pu targets. Systematic variations in the experimental results are used to qualitatively discuss properties of the fission barrier and low-lying transition-state spectra for these even-even nuclei. (auth)

7881 TRANSITION MIXING RATIOS DETERMINED FROM A STUDY OF THE ELECTRON AND GAMMA-RAY DISTRIBUTIONS FROM ORIENTED ^{192}Ir. Hirshfeld, Alan T.; Hoppes, Dale D. (National Bureau of Standards, Washington, D. C.). Phys. Rev., C; 2: 2341-9(Dec 1970).

The angular distributions measured for 12 γ rays in ^{192}Os and ^{192}Pt resulting from the decay of cryogenically oriented ^{192}Ir were used to determine the following E2/M1 mixing ratios: 201 keV, $\delta^2 > 3.7$; 296 keV, $\delta = -(6)$; 308 keV, $\delta = -(7.1 \pm 0.6)$; 417 keV, $\delta = 4$; 485 keV, $\delta = 5.8 \pm 0.8$; 604 keV, $\delta = 1.5 \pm 0.1$, following the Rose–Brink sign convention. The angular distribution of the 672-keV β group and the above γ measurements limit the relative contribution, I_L, of different operator tensor ranks, L, involved in each β transition. The results for electron-capture transitions terminating at levels in osmium are: 694-keV level, $I_1 > 0.9$; 584-keV level, $I_0 > 0.6$, $I_2 < 0.1$. For β transitions feeding platinum states, the following were determined: 921-keV level, $I_1 >$

0.8; 785-keV level, $I_1 > 0.92$, $I_2 < 0.03$. The ^{192}Ir ground-state magnetic moment is determined to be positive. (auth)

7882 STUDY OF THE LEVELS IN ^{140}La USING THE ^{139}La $(n,\gamma)^{140}$La REACTION. Jurney, E. T. (Los Alamos Scientific Lab., N. Mex.); Sheline, R. K.; Shera, E. B.; (and others). Phys. Rev., C; 2: 2323-40(Dec 1970).

The levels in ^{140}La were studied following thermal-neutron capture in ^{139}La using Ge(Li), Si(Li), curved-crystal, and coincidence spectrometers. The neutron binding energy of ^{140}La was determined as 5161.1 ± 1.0 keV. The data, when combined with the previous ^{139}La(d,p)^{140}La study, allow the assignment of the first 14 states up to 581.060 keV to the mixed configurations $\pi g_{\frac{9}{2}}\nu f_{\frac{5}{2}}$ and $\pi d_{\frac{5}{2}}\nu f_{\frac{5}{2}}$. The energies of states in keV (spin parity) are: 0 (3$^-$), 29.965 (2$^-$), 34.656 (5$^-$), 43.811 (1$^-$), 48.865 (6$^-$), 63.171 (4$^-$), 103.803 (6$^-$), 162.656 (2$^-$), 272.311 (4$^-$), 284.634 (7$^-$), 318.214 (3$^-$), 322.003 (5$^-$), 467.505 (1$^-$), 581.060 (0$^-$). Comparisons of γ-ray branching ratios and (d,p) cross sections with the predictions of a quasiparticle model for odd-odd nuclei allow a relatively uncompromised solution for the state vectors for the first 14 states. The success of this model implies that there is little phonon or four-quasiparticle admixture through the level at 581.060 keV. A detailed experimental study of additional levels up to 1055 keV was performed. (auth)

Nuclear Theory

Refer also to abstracts 7599, 7614, 7690, 7693, 7847, and 7859.

7883 (BARC/I-36) LECTURES ON NUCLEAR CROSS SECTIONS. Garg, S. B. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 86p. Dep. CFSTI (U. S. Sales Only).

A series of lectures intended to familiarize reactor physicists with the various techniques for calculating neutron cross sections are presented. The lectures include a review of nuclear cross-section data, a review of nuclear reactions, Breit–Wigner theory, self-shielding and Doppler broadening of resonances, R-matrix theory, and the optical model. (J.W.R.)

7884 (ITF-70-44) MODEL OF THE RIGID NONAXIAL ROTATOR FOR THE ODD ATOMIC NUCLEI. Sardaryan, R. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The model of the odd nonaxial nucleus developed by Pashkevich and Sardaryan is considered with the added restriction that the projection of the external nucleon moment on the axis is conserved. This assumption, valid for small deviations of the shape of the nucleus from the axial-symmetric one, essentially simplifies the Hamiltonian and allows the study of the main and anomalous rotational bands constructed on the ground state of the nucleus. The calculated spectra are compared with the experimental ones of the spin-$\frac{5}{2}$ nuclei ^{183}Re, ^{185}Re, ^{187}Re, ^{169}Yb, ^{171}Yb, ^{173}Yb, ^{169}Er, and ^{171}Er. (auth)

7885 (ITF-70-47) ROTATIONAL-ONE-PARTICLE EXCITATIONS IN THE MODEL OF NONAXIAL ODD NUCLEUS WITH ALLOWANCE FOR ITS DEFORMABILITY. Kashuba, I. E.; Golubova, A. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 44p. (In Russian). Dep. NTIS (U. S. Sales Only).

Within the framework of the model of the non-axial odd nucleus developed earlier by Davydov, Sardaryan, and Pashkevich, the low-energy spectrum of the excited states of odd nuclei with spins of the ground states equal to $\frac{7}{2}$ and $\frac{9}{2}$ is considered. In this case nonadiabatics with respect to the β vibrations of nuclear surface ($\mu \pm 0$) is taken into account. The results of the numerical calculations of the wave functions and the energies of the excited states are given in the form of tables and graphs, respectively. The calculated energies of excitations are compared with the experimental values for the nuclei ^{177}Lu and ^{181}Ta. (auth)

7886 (JINR-P2-5328) THEORY OF THE RESONANCE SCATTERING IN THE PRESENCE OF OVERLAPPING LEVELS WITH THE IDENTICAL CONSERVED QUANTUM NUMBERS. Lyuboshits, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1970. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

With the notion of nonorthogonality of the quasi-stationary states with identical conserved inner quantum numbers as a basis, the generalized Breit–Wigner formula is discussed for the amplitude of the resonance multichannel scattering in the presence of some overlapping levels. (auth)

7887 (STI/PUB-249) THEORY OF NUCLEAR STRUCTURE: TRIESTE LECTURES 1969. Lectures Presented at Trieste from January 7–March 31, 1969. (International Atomic Energy Agency, Vienna (Austria). International Centre for Theoretical Physics, Trieste (Italy)). 1970. 961p. IAEA $24.00.

Separate abstracts are prepared for each of thirty-five lectures contained in this publication. (R.W.R.)

For abstracts of individual lectures see: 6946, 7821, 7859, and 7889–7920.

7888 (UCRL-19530, pp 107-62) NUCLEAR THEORY. (California Univ., Berkeley. Lawrence Radiation Lab.).

From nuclear chemistry division annual report, 1969.

ALPHA PARTICLES—deuteron reactions (d,p) at 10.1 MeV, analysis for inelastic processes in, (T)
ARGON-36—energy levels of, Hartree–Fock–Bogoliubov calculations for, (T)
CALCIUM-48—helium-3 reactions (He-3,t) with, analysis for space exchange effects in, (T)
—alpha inelastic scattering by, analysis for space exchange effects in, (T)
—helium-3 inelastic scattering by, analysis for space exchange effects in, (T)
—triton inelastic scattering by, analysis for space exchange effects in, (T)
—proton inelastic scattering at 12 MeV, calculation including exchange effects and two-step transfer processes, (T)
CALIFORNIUM-252—fission of, fractional independent yields in spontaneous, (T)
DYSPROSIUM-168—energy levels of, microscopic description of vibrational, (T)
DYSPROSIUM-172—energy levels of, microscopic description of vibrational, (T)
DYSPROSIUM-174—energy levels of, microscopic description of vibrational, (T)
DYSPROSIUM-176—energy levels of, microscopic description of vibrational, (T)
ERBIUM-168—energy levels of, microscopic description of vibrational, (T)
ERBIUM-170—energy levels of, microscopic description of vibrational, (T)
GADOLINIUM-155—energy levels at 86.5 and 105.3 keV, calculation of magnetic moments for, (T)
HYPERFRAGMENTS—binding energies of Λ-^{9}Be, Λ-^{13}C, and Λ-^{5}He, calculations using potential from phase shifts, (T)
LEAD-210—proton reactions (p,t) at 20 MeV, calculations using two-step transfer processes, (T)
MAGNESIUM-24—deuteron reactions (d,p) at 10.1 MeV, analysis for inelastic processes in, (T)
—energy levels of, Hartree–Fock–Bogoliubov calculations for, (T)
SULFUR-32—energy levels of, Hartree–Fock–Bogoliubov calculations for, (T)
TIN ISOTOPES—energy levels of, calculations using Hartree–Fock–Bogoliubov method with pairing correlations, (T)
TRITONS—deuteron reactions (d,p) at 10.1 MeV, analysis for inelastic processes in, (T)

7889 NUCLEON–NUCLEON INTERACTIONS. Brink, D. M. (Oxford Univ.). pp 3-15 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970). See STI/PUB-249.

The present state of knowledge and understanding of nucleon–nucleon interactions is discussed. Physical laws satisfy a number of general symmetry principles which lead to conservation laws; these symmetries place restrictions on the form of the nucleon–nucleon interaction. The two-nucleon scattering amplitude can be specified by giving the elements of the scattering matrix; if the matrix is diagonal, the elements can be represented by phase shifts. In investigating nuclear structure it is convenient to try to represent internucleon interactions by a potential. The radial, spin, and isospin dependence of potentials is discussed generally, as well as the uniqueness of the potential. The meson theory of nuclear forces and various phenomenological potentials are mentioned. (R.W.R.)

7890 EXPERIMENTAL ASPECTS OF NUCLEAR INTERACTION. Slaus, I. (Rudjer Boskovic Inst., Zagreb). pp 17-56 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).

See STI/PUB-249.

Experimental information determining various aspects of the nuclear interaction is discussed. After reviewing nucleon–nucleon collisions and the knowledge of the N–N force gained

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from them, the author discusses the phase-shift analysis of p–p and n–p data. Experimental problems in p–p and n–p scattering are considered, including those involving polarized beams and targets. After summarizing N–N potential models for small N–N distances, the author enumerates those areas in which our understanding of the nuclear interaction is insufficiant, discussing in detail the off-energy-shell interaction and the neutron–neutron interaction. (131 references) (R.W.R.)

7891 NUCLEAR BINDING ENERGIES AND DENSITIES. Brink, D. M. (Oxford Univ.). pp 59-66 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The properties of nuclear matter are discussed from the points of view of the Fermi theory and the Landau theory. After the contributions of the surface energy and the Coulomb energy to the binding energies of finite nuclei are also defined, several mass formulas to account for the variations of nuclear binding energies with N and Z are presented. (R.W.R.)

7892 BASIC CONCEPTS AND PROPERTIES OF COLLECTIVE MOTION AND THE SINGLE-PARTICLE STATES IN DEFORMED NUCLEI. Szymanski, Z. (Inst. for Nuclear Research, Warsaw). pp 67-127 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

After a discussion of the charge and matter distributions in nuclei, the semi-empirical mass formula is derived and new developments along these lines are mentioned. The Nilsson model is developed by considering individual nucleon motion in the non-spherical potential field. The factors responsible for the polarizability of the nuclear core are enumerated, and methods for the determination of the nuclear shape are discussed. The various tendencies in nuclear motion responsible for the onset of nuclear deformation are next described. Then the fundamental principles underlying the structure of rotational motion in deformed nuclei are formulated, and the main consequences of these assumptions are discussed. These include the rotational spectra of even–even and odd-A nuclei, the intensity rules governing the energy-level transitions in nuclei, methods of verifying the intrinsic structure in the nuclear deformed orbitals, and the rotational spectra of odd–odd nuclei. The deviations from this rotational coupling scheme are mentioned, and the theory is extended in order to explain the systematics of the observed deviations. The properties of heavy nuclei are discussed, and the study of nuclear structure is extended into the states of very highly distorted nuclei in order to explain nuclear fission. Finally, the theory of strongly deformed nuclei is extrapolated into the region of superheavy nuclei with $Z \gtrsim 110$ and $N \approx 184$. (R.W.R.)

7893 FUNDAMENTALS AND ELEMENTARY OUTLINE OF THE MANY-BODY THEORY OF NUCLEAR MATTER. Dabrowski, J. (Inst. for Nuclear Research, Warsaw). pp 131-84 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The fundamentals of the Brueckner theory of nuclear matter are discussed. The starting point is the system of non-interacting nucleons (the Fermi gas). The expression for ΔE, the correction to the ground-state energy due to the inter-nucleon interaction, is written down and calculated in the second quantization formalism with the help of Wick's theorem. The diagrams used in the theory of nuclear matter are explained, as well as the simplifications permitted by the linked-cluster theorem and momentum conservation; Feynman and Goldstone diagrams are used to do the time integrations. The low-density approximation (or ladder approximation) is used as a starting point in a systematic procedure for evaluating higher-order density terms, and the K matrix is introduced. The most important of the third-order diagrams in K, the "hole-self-energy" diagrams, are discussed; the K-matrix equation is solved by the Brueckner–Gammel method. The reason for the success of the shell-model approximation, in which nucleons move independently, is pointed out. The $Q = 1$ approximation for solving the K-matrix equation is explained, and a quantitative estimate of the convergence of the theory is given. Bethe's treatment of the remaining third-order diagrams is summarized and recent nuclear matter calculations are reviewed. (R.W.R.)

7894 SYMMETRY PROPERTIES OF NUCLEAR VIBRATIONS. Bohr, A. (Niels Bohr Inst., Copenhagen). pp 187-93 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

A brief survey of some problems in the field of nuclear vibrational modes, based on a collective description, is given. (auth)

7895 BASIC CONCEPTS OF THE SHELL MODEL AND SOME SIMPLE EXCITATION MODES IN NUCLEI. Alaga, G. (Rudjer Boskovic Inst., Zagreb). pp 195-226 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The basic ideas of the shell model and the properties of single-particle states are presented; it appears that discrepancies between measured and calculated properties of the nuclei around the doubly closed shells can be remedied in terms of the effective electromagnetic and beta-decay operators. The theory is then generalized to include simple features of some two-body and many-body systems, i.e., systems with two or more particles or holes outside the closed shells. (R.W.R.)

7896 SHELL-MODEL TECHNIQUES. Soper, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 227-39 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

Slater determinants (second-quantized wave functions) are used to represent the states of a many-body system. Coefficients of fractional parentage are introduced to simplify the determinant representation. Examples of the calculation of one- and two-body matrix elements are then given, both for the general method and the simplified method that is possible when the radial wave functions are those of a harmonic oscillator. (R.W.R.)

7897 BASIC EVIDENCE AND PROPERTIES OF SINGLE-PARTICLE STATES IN NUCLEI. Cindro, N. (Rudjer Boskovic Inst., Zagreb). pp 241-81 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

After some preliminary remarks about the validity of the shell-model picture, some critical points concerning known information about single-particle orbitals are reviewed. The bulk of the paper is concerned with experimental evidence in favor of the shell model found in the lead region, in the calcium region, and in nuclei far from closed shells. The paper concludes with some comments on what is meant by saying that a state is well described by a certain model. (R.W.R.)

7898 CHARGE INDEPENDENCE IN NUCLEAR PHYSICS. Fonda, L. (Univ., Trieste, Italy). pp 283-95 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The isotopic-spin formalism is introduced to describe the charge states of nuclei. After the evidence for charge symmetry and charge independence is presented, the generalized Pauli principle, selection rules for nuclear reactions, electromagnetic transitions, beta decay, and mass splitting of nuclei are treated. The relation between finite groups and charge independence is discussed, and the utility of isotopic spin as a quantum number in heavy nuclei is considered. (R.W.R.)

7899 STRUCTURE INFORMATION FROM DIRECT NUCLEAR REACTIONS. Frahn, W. E. (Univ. of Cape Town). pp 297-340 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

After a survey of the different kinds of one- and two-nucleon transfer processes, the DWBA theory of direct reactions is described for these processes. From a discussion of the approximations and uncertainties involved in this method, the reliability of the calculated spectroscopic factors is estimated. A brief description of how these factors are calculated is given for one- and two-nucleon transfers in the shell and pairing-force models. The theory is compared with typical experiments on one-nucleon-transfer in the 1p shell, the Ca isotopes, the Sn isotopes, and the Pb region; and with experiments on two-nucleon transfer, principally in the lead region. (98 references) (R.W.R.)

7900 SPECTROSCOPIC INFORMATION FROM NUCLEAR REACTIONS. von Brentano, P.; Dost, M.; Harney, H. L. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 341-58 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

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The problem of extracting nuclear structure information from nuclear reactions using the (d,p) stripping reaction below the Coulomb barrier and inelastic proton scattering via analog resonances is discussed. Useful information is primarily obtained from reactions which are dominated by only one reaction mode. The analysis proceeds in two steps: the cross section is parametrized by a small set of unambiguously determined reaction widths which are model independent; from the reaction widths spectroscopic factors are derived by using knowledge of the form factor and the optical-model wave functions inside the nucleus. (R.W.R.)

7901 HARTREE–FOCK CALCULATIONS FOR LIGHT NUCLEI. Bouten, M. (CEEN, Mol-Donk, Belg.). pp 361-412 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB–249.

A derivation of the Hartree–Fock equations is given, starting from Schrödinger's variational principle with the assumption that the nuclear Hamiltonian is not singular. The approximations which are usually made to find actual solutions of the Hartree–Fock equations are described, as well as some selected results obtained in Hartree–Fock calculations. When and how an angular momentum projection can be carried out without too much labor is next demonstrated. A description of how projected Hartree–Fock calculations can be made in an approximate way for nuclei with $4 \leq A \leq 12$ is given along with the results for energies and wave functions of such calculations. Finally, these wave functions are tested by calculating several physical quantities, and it is shown that the enhanced matrix elements of collective moments and transitions are systematically reproduced. (R.W.R.)

7902 HARTREE–FOCK CALCULATIONS IN DEFORMED LIGHT AND MEDIUM-LIGHT NUCLEI. Svenne, J. P. (Institut de Physique Nucleaire, Orsay, France). pp 413-25 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB–249.

The Hartree–Fock solution to the many-body problem is examined using a phenomenological potential and an inert core. After justification for the use of the inert core, some details of the calculation and characteristic features of the results of even–even, s–d shell nuclei are given. After the necessity for projection of rotational states is set forth, the theory is extended to the 2p–1f shells and to major-shell-mixing unrestricted Hartree–Fock calculations. (R.W.R.)

7903 PAIRING VIBRATIONS AND TWO-PARTICLE TWO-HOLE ADMIXTURES. Ripka, G.; Padjen, R. (CEN de Saclay, Gif-sur-Yvette, France). pp 427-51 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB–249.

The pairing mode of vibration of normal systems and the two-particle–two-hole admixtures to the Hartree–Fock states of 2s–1d shell nuclei are treated. First, both pairing and R.P.A. vibrations are derived at the same time by considering time-dependent Hartree–Bogolyubov theory. Then the same equations are derived by the generator-coordinate method. Finally, the methods and results of the calculations of two-particle–two-hole admixtures to the Hartree–Fock states of N = Z even–even nuclei in the 2s–1d shell are discussed. (R.W.R.)

7904 SIMPLE SHELL MODEL AND EFFECTIVE NUCLEAR FORCES. Talmi, I. (Weizmann Inst. of Science, Rehovoth, Israel). pp 455-81 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB–249.

Spherical nuclei are considered in a simple shell model in an attempt to obtain significant quantitative predictions. Effective interactions are determined by the phenomenological approach of examining the experimental data. The case of identical nucleons outside a closed shell is considered, and the value of the energy gap is derived for the $(d_{\frac{5}{2}})^2$ and $(d_{\frac{5}{2}})^3$ configurations using the pairing interaction. The variation in binding energy between odd and even nuclei is discussed. It is shown that nuclei with magic proton or neutron numbers are not more tightly bound than their preceding even–even nuclei; the significant feature is a large drop in the separation energy beyond a magic number. Binding energies are next considered for both protons and neutrons outside closed shells, and it is shown that proton–neutron interactions are important. When both kinds of nucleons are present, the repulsion between identical nucleons is more than compensated by the attraction between unlike particles; this is also true for protons and neutrons in different orbits. Thus, the forces that give rise to the attractive central potential of the shell model are the proton–neutron interactions. A more detailed look at the proton–neutron interaction shows that it gives rise to high-spin isomeric states owing to the existence of "spin gaps". The paper concludes with a discussion of configuration mixing, hidden and explicit, which lies at the foundation of the effective-interaction approach. (R.W.R.)

7905 PSEUDONUCLEI AND THE SHELL MODEL. Soper, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 483-97 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB–249.

"Pseudo-nuclei" are constructed in a physically reasonable way from wave functions which contain configuration admixtures. Matrix elements of operators representing physically observable quantities are then calculated between these wave functions. These quantities correspond to experimental data in real nuclei—they are "results of pseudo-experiments". Then, by taking account only of these pseudo-data (and not using knowledge of the true wave function), an attempt is made to find the simplest model assumptions that will give a reasonable fit to the properties of the system. The quality of the fit can be compared to that obtained with real nuclei, and the simple wave functions can be compared with the true wave functions (which are known). It is shown that the general run of nuclear physics experiments gives no clue at all to the large configuration admixtures: simple single-particle assumptions produce fits to the pseudo-data that are at least as good as those obtained in real life with real nuclei. (R.W.R.)

7906 SOME TECHNIQUES AND APPROXIMATIONS IN THE NUCLEAR SHELL MODEL. Arvieu, R. (Institut de Physique Nucleaire, Orsay, France). pp 499-545 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB–249.

The paper develops and discusses some of the techniques which are in use in the nuclear shell model. It concentrates on the N-body problem of finding some solutions, exact or approximate, of the shell-model Hamiltonian and the properties of eigenvalues and eigenfunctions resulting from such a calculation. After a description of the model and its assumptions about single-particle energies and the two-body interaction, spectra of two and three particles are calculated. Seniority is introduced by discussing the representation in which the surface-delta interaction is diagonal, i.e., the generalized seniority representation or quasi-spin scheme. The tensorial character of various operators and its consequences are examined. The quasi-particle method is then applied to those interactions which are diagonal in the generalized seniority representation (scalar interactions). The general two-body force is expanded, and its terms are examined for symmetry breaking. The effects of these terms on the properties of the system itself are presented. (R.W.R.)

7907 THEORY OF NUCLEAR VIBRATION. Pal, M. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 547-695 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB–249.

A microscopic theory of nuclear vibration is developed by the coherent superposition of quasi-particle pair states. After a survey of the general theory of vibration, the nuclear vibrational equations are derived by a time-dependent treatment containing the semi-classical picture of an oscillating density distribution. A more formal derivation of the general microscopic theory for quasi-particles is then given, and the term which actually represents the interaction between quasi-particles is treated in some detail. Application of the theory is made to the vibrational states in closed-shell nuclei, spherical non-closed-shell nuclei, and deformed nuclei. (R.W.R.)

7908 REALISTIC POTENTIALS IN NUCLEAR-STRUCTURE CALCULATION. Gmitro, M. (Nuclear Research Inst., Rez, Czech.). pp 697-711 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB–249.

The use of potentials which were determined from an analysis of nucleon–nucleon scattering and deuteron data in nuclear spectroscopy is reviewed. A dynamic description by velocity-dependent potentials and a static description using repulsive cores are considered. The latter case is examined in the context of the Brueckner reaction matrix, and the approximations necessary for solution by the separation method and the reference spectrum method are given. The use of a model space is illustrated for dealing with the renormalization problem. (R.W.R.)

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7909 EFFECTIVE ELECTROMAGNETIC OPERATORS. Rimini, A. (Univ., Trieste, Italy). pp 713-28 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970). See STI/PUB-249.

The fundamental ideas of the theory of effective interactions and electromagnetic (em) operators are reviewed. The advantages and drawbacks of the microscopic and phenomenological determinations of the effective quantities are discussed. The method of separating core and valence energies is described. The explicit formulas for the effective em operators are given. Two calculations concerning tin and nickel isotopes are described, and the results are discussed. (auth)

7910 SHELL-MODEL DESCRIPTION OF NUCLEAR REACTIONS. Mahaux, C. (Univ., Liege). pp 731-66 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

A specific shell-model description of nuclear reactions is given. The independent-particle model is first studied, in which the Hamiltonian of the model H_0 is just the sum of single-particle Hamiltonians and the residual interaction is neglected. Expressions are written down for the single-particle bound and scattering states and the scattering function, and the eigenstates of H_0 are constructed. The relation between resonances and the bound states embedded in the continuum is discussed; and the role of the residual interaction exhibited. The basic equations of the bound-state problem and the scattering problem are given; the latter can be put into the form of the Lippmann–Schwinger equation. An expression for the scattering matrix is obtained, and application of the formalism is made to the giant resonances in light even–even nuclei. The application of the shell to intermediate structure is next discussed. After the definition of the doorway states, a simple model is studied which makes predictions concerning both the average cross section and the fine structure. The status of experimental evidence regarding the model is given. Finally, the shell model is applied to the isobaric analog resonances(IAR). The topics considered are the isospin of neutron-excess nuclei and isobaric analog states, the fine structure and neutron decay of IAR, the basis states and their mutual coupling, and isospin mixing at the IAR. The kind of spectroscopic information obtainable from the IAR is pointed out. (R.W.R.)

7911 HARTREE–FOCK APPROXIMATION IN CO-ORDINATE SPACE. Vautherin, D. (Institut de Physique Nucleaire, Orsay, France). pp 767-95 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The properties and method of solution of the Hartree–Fock integro-differential system for spherical nuclei are discussed. The use of the coordinate-space representation allows a qualitative understanding of the dependence of the results on the parameters of the two-body interaction. The iteration process used in the solution of the non-local Schrödinger equation for bound states is described. The effective interaction of Brink and Boeker is extended to $N \neq Z$ systems, and a two-body spin-orbit force is added. Results are given for nuclear radii, densities, single-particle energies, Coulomb-displacement energies, and electron scattering cross sections; local equivalent potentials and overlaps with oscillator wave functions are also presented. Some applications of the Hartree–Fock techniques to scattering problems are given. The Hartree–Fock field appears to give a reasonable first-order description of single-particle properties obtained from a wide range of experiments. (R.W.R.)

7912 HIGH-ENERGY SCATTERING OF COMPOSITE HADRONS. Czyz, W. (Inst. of Nuclear Physics, Krakow). pp 797-823 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The theory of high-energy potential scattering is discussed; and the theory is then extrapolated to high-energy, small-angle nuclear scattering. After formulation this model is applied to proton elastic scattering at 1 GeV from ^{12}C, ^{4}He, and ^{16}O. Finally, the model is further extrapolated from high-energy nuclear scattering to very-high-energy hadron–hadron scattering (e.g., proton–proton scattering). (R.W.R.)

7913 PHOTO- AND ELECTRO-DISINTEGRATION OF NUCLEI AND EXCHANGE CURRENTS. Bosco, B. (Univ., Cagliari, Italy). pp 825-33 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The connection between photo- and electrodisintegration of nuclei is reviewed, with particular emphasis on the magnetic dipole. It is shown that there is a simple proportionality between the cross sections for the magnetic-dipole disintegration induced by photons and by electrons, the proportionality factor being a definite function of the electron kinematical variables in the absence of exchange currents. The nuclear tensors are then written down for the case where exchange currents are present. In this case the above proportionality function is multiplied by a factor $(1 + \epsilon)$, where ϵ is determined by the coefficients of the Foldy–Osborn invariants and can be found by the proper experiment. The presence of d waves in the deuteron is then taken into account, and an expression is derived in which the interference between s and d waves is removed. (R.W.R.)

7914 NUCLEON–NUCLEON POTENTIAL WITH A SOFT CORE FOR THE ISOTOPIC TRIPLET STATE. Ulehla, I.; Bystricky, J.; Humhal, E.; Lehar, F.; Lelek, V.; Wiesner, J. (Charles Univ., Prague). pp 837-45 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

A soft-core two-nucleon potential is computed as a superposition of Yukawa potentials. It contains the central, spin, spin-orbit, quadratic spin-orbit, and tensor terms and depends on the total angular momentum J. The parameters of the individual terms are given for the isotopic triplet state of the two-nucleon system. (auth)

7915 THOMAS–FERMI THEORY OF ATOMIC NUCLEI. Nemeth, J. (Roland-Eoetvoes-Univ., Budapest). pp 847-55 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The derivation of an integral equation for the density of nuclear matter is given. Its solution gives the energy and the density of nuclei as a function of their mass number. (auth)

7916 COUPLED-CHANNEL CALCULATION OF THE INTERACTION OF NUCLEONS WITH THE COLLECTIVE MODES OF NUCLEI. Pisent, G. (Univ., Padua). pp 873-8 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

A model Hamiltonian for the description of the target spectrum is first written down; the total wave function is then represented by the model wave functions by truncation of the representation space. By introducing the extreme surface coupling model the system of equations can be integrated easily. This model can be used to generate "intermediate" resonances. The physical ideas which underlie the coupled-channel approach can be interpreted in terms of collective doorway states. (R.W.R.)

7917 OPTICAL MODEL AND DIRECT REACTIONS. Agodi, A. (Univ., Catania, Italy). pp 879-94 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

This presentation of the optical model permits a study of the relation between gross structure and fine structure of nuclear cross sections by starting from any approximate solution of the nuclear many-body problem. In particular, new insights into the theory of direct nuclear reactions are provided. (auth)

7918 HARTREE–FOCK–BOGOLYUBOV CALCULATIONS. Wolter, H. H. (Univ., Muenster, Ger.). pp 895-901 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

The effects of pairing correlations on the nuclear wave function are discussed. It is shown that, for many nuclei in the p–f shell, the Hartree–Fock approximation is not valid. (auth)

7919 SEPARATION AND PAIRING ENERGIES IN SPHERICAL NUCLEI. Beiner, M. (Institut de Physique Nucleaire, Orsay, France). pp 903-30 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).
See STI/PUB-249.

Separation energies of nucleons as well as pairing properties are calculated for spherical nuclei and systematically compared with experimental data. The spherical odd nuclei (Z or $N \gg 15$) are represented by 31 "mean odd-Z nuclei", $(Z, \bar{N}(Z))$, and by 46 "mean odd-N nuclei", $(\bar{Z}(N), N)$. $\bar{N}(Z)$ and $\bar{Z}(N)$ being real mean values (in general non-integer) associated with any odd number Z and N, respectively. By using a local average potential

(depending on few constants) in order to obtain sets of single-particle states and introducing computed realistic pairing matrices into the gap equations, theoretical predictions are obtained which are in good agreement with the corresponding empirical data. (auth)

7920 MICROSCOPIC DERIVATION OF THE OPTICAL POTENTIAL. Vinh-Mau, N. (Institut de Physique Nucleaire, Orsay, France). pp 931-9 of Theory of Nuclear Structure: Trieste Lectures 1969. Vienna; International Atomic Energy Agency (1970).

See STI/PUB-249.

An attempt is made to determine an optical potential from microscopic many-body theory by taking into account all the effects of antisymmetrization. (auth)

7921 ENERGY DEPENDENCE OF THE EFFECTIVE INTERACTION. Kleber, M. (Technische Univ., Munich). Z. Phys.; 239: 395-408(1970).

The Schroedinger equation is studied in a finite subspace of the Hilbert space. The truncation of the configuration space makes the (effective) interaction energy-dependent. This dependency is investigated. An analytic expression for the matrix elements of the effective interaction is established for the schematic model, for the displaced harmonic oscillator, for a simple random-phase problem and for a pairing force model. Thereby the phase transitions from bound to unbound states and from normal to superconducting states are analyzed. (auth)

7922 STRUCTURE OF FINITE NUCLEI IN THE LOCAL DENSITY APPROXIMATION. Negele, John William. Ithaca, N. Y.; Cornell Univ. (1969). 230p. University Microfilms Order No. 70-11,242.

Thesis.

A new theory is presented for calculating the structure of finite nuclei from the nucleon–nucleon interaction. The essential features of the reaction matrix in finite nuclei are obtained from nuclear matter theory through the local density approximation. The resulting density and energy dependent effective interaction is justified in detail, and it is shown that the tensor force plays an important role in saturation. The effective interaction is cast into two different forms, one convenient for use in calculating matrix elements and the other specialized for a Hartree–Fock calculation in position space. The density dependent Hartree–Fock equations are derived by variation of the ground state expectation value of the energy, and in addition to the usual Hartree–Fock terms, one obtains rearrangement terms arising from the variation of the density appearing in the density dependent interaction. The appropriate angular momentum reduction for closed j-shell nuclei is performed. The need for modifying the effective interaction to account for higher order corrections is discussed, and the constraints imposed on this modification by the properties of nuclear matter are examined. The results of this theory for ^{16}O, ^{40}Ca, ^{48}Ca, ^{90}Zr, and ^{208}Pb are shown to yield very satisfactory agreement with experimental binding energies, single particle energies, and electron scattering cross sections. The rearrangement terms in the density dependent theory are demonstrated to have two essential effects on nuclear structure: a significant reduction in the central density of the nucleus and a modification of the usual Hartree–Fock relation between single particle energies and the binding energy. Equivalent local single particle potentials are calculated and are shown to have significant state dependence. (Diss. Abstr. Int., B)

7923 INFLUENCE OF NUCLEAR FORCES ON THE COULOMB BARRIER IN HEAVY-ION REACTIONS. Riesenfeldt, Peter W.; Thomas, T. Darrah (Princeton Univ., N. J.). Phys. Rev., C; 2: 2448-9(Dec 1970).

Holm and Greiner have shown the effect of nuclear diffuseness on the barrier against fusion of two heavy nuclei. It is shown that the major part of this effect is a lowering of the barrier because of the diffuseness alone. There is an additional change in the barrier, due to deformation effects, which may be either positive or negative depending on the relative importance of the Coulomb and nuclear parts of the potential. (auth)

7924 THERMONUCLEAR-REACTION RATES AT HIGH TEMPERATURE. Michaud, Georges; Fowler, William A. (California Inst. of Tech., Pasadena). Phys. Rev., C; 2: 2041-9(Dec 1970).

Thermonuclear-reaction rates were calculated over the temperature range $2 \leq (T/10^9)°K \leq 6$ for some cases of particular interest in nucleosynthesis during silicon burning (Michaud and Fowler). The calculations are explicitly related to the evaporation theory and the optical model for particle channels. For γ-ray channels an approximate formula fitted to the experimental results of Macklin and Gibbons on radiative capture reactions for neutrons is developed. The calculated rates are compared with available data and the effect of excited states is discussed. (auth)

7925 TENSOR-FORCE EFFECTS ON THE l-FORBIDDEN M1 TRANSITIONS. Hsieh, S. T.; Ogata, H. (Univ. of Windsor, Ont.). Phys. Rev., C; 2: 2091-6(Dec 1970).

The reduced matrix elements for the l-forbidden M1 transitions are calculated in the framework of the pairing model. Three quasiparticle states are admixed to the seniority-one state by perturbation due to the short range δ force and the tensor force. It is shown that the mixing of the tensor force is essential to explain the observed values of the reduced matrix elements. (auth)

7926 TWO-PION-EXCHANGE THREE-BODY FORCE IN NUCLEAR MATTER. Bhaduri, R. K.; Nogami, Y.; Ross, C. K. (McMaster Univ., Hamilton, Ont.). Phys. Rev., C; 2: 2082-91 (Dec 1970).

The contribution of the two-pion-exchange three-nucleon force to the binding energy of nuclear matter is evaluated using the modified pion-mass method of Brown and Green and by the conventional potential approach. Using nonrelativistic formulas, the relation between the two methods is clarified. It is shown that the Brown–Green prescription, as given in their paper, is incorrect when a cutoff in the NN distance is applied and the modified pion mass is momentum dependent. When the correct prescription is used, the first-order contribution becomes sensitive to the pionic form factor chosen. Using the same form factor as used by Brown and Green, the contribution with an NN cutoff of 1 F is only about 0.1 MeV instead of 1.25-MeV repulsion per particle as quoted by them. Another form factor leads to above 0.5-MeV repulsion. The second-order contribution, including the cross terms involving the two-body one-pion-exchange potential and three-body forces, was recalculated in the Brown–Green spirit after correcting for their earlier error. It is attractive, much larger than the first-order term, and is about the same for the two form factors used. The net effect of the two-pion-exchange three-body force is rather sensitive to the NN cutoff and is about a 4- to 8-MeV per particle attraction in nuclear matter, depending on the cutoff. (auth)

7927 BINDING ENERGIES OF FINITE NUCLEI IN THE OSCILLATOR MODEL. Gunye, M. R.; Warke, Chindhu S. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., C; 2: 2106-12(Dec 1970).

The oscillator model for calculating the binding energies of finite nuclei is studied. The general properties of the coefficients of the reduced matrix elements occurring in the binding-energy expression are discussed. The numerical values of these coefficients for the nuclei up to ^{208}Pb are tabulated. The model has been tested by comparing its results with those of the Hartree–Fock calculations. It is found that the accuracy of the model in predicting the binding energies and rms radii is quite good. (auth)

7928 OFF-ENERGY-SHELL T MATRIX FOR LOCAL POTENTIALS WITH SINGULAR CORE INTERACTIONS. II. TENSOR AND COULOMB FORCES. Kim, Y. E.; Tubis, A. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 2: 2118-27(Dec 1970).

A previous derivation of an integral equation, which gives the complete off-energy-shell t matrix for two-body scattering via local potentials with singular core interactions, is generalized to include the effects of tensor and Coulomb forces. The core interaction is described by the boundary-condition model (specified energy-independent logarithmic derivative of the radial wave function at the core radius). The formalism is now being applied to the calculation of trinucleon bound-state and scattering parameters using the Faddeev formalism and realistic nucleon-nucleon forces. (auth)

7929 OFF-SHELL CONTINUATION OF THE TWO-BODY T MATRIX WITH FIXED ON-SHELL BEHAVIOR. Amado, R. D. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 2: 2439-41(Dec 1970).

The off-shell continuation of the two-body T matrix is written in terms of a T matrix that is correct on-shell plus a term that effects only the off-shell behavior. The work of Baranger et al. and of Haftel is used to show what is arbitrary in the off-shell term for fixed on-shell data. (auth)

XUM

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 6501.

7930 (BMBW-FBK-70-22) NUCLEAR SUPERHEAT REACTOR KAHL (HDR), RESEARCH AND DEVELOPMENT PROGRAM (PHASE B). Final Report. Eisfelder, H.-J. (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Grosswelzheim (West Germany)). Oct 1970. 127p. (In German). Dep. NTIS (U. S. Sales Only).

The development of an angular superheat fuel rod for the HDR between 1964 and 1968 is described. The cladding materials program included corrosion and heat resistance tests leading to the choice of Inconel 625 or IN 102 for the superheater can and of 16/16 or 16/13 Cr/Ni steels for the boiler can. In thermocycling tests canning materials and end plugs were tested within complete angular fuel rods. Fuel rods of different design and material combinations were irradiated in the VAK. After a maximum 546 days irradiation a peak burn up of 11.3 MWd/kg was achieved. A prototype bundle was fabricated and handling tests were performed. (auth)

7931 (CEA-N-1394) INTERPRETATION OF THE EXPERIMENTS CARRIED OUT ON THE MODEL OF BUGEY AXIAL AND LATERAL CAVITIES. Bourdet, Lucien; Duco, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 45p. (In French). Dep. NTIS (U. S. Sales Only).

The results of shielding formulas with regard to neutron and γ fluxes in axial and lateral cavities of gas graphite reactors were compared with experimental results obtained on a mockup. 20 references. (France)

7932 FABRICATION OF THE PRESSURIZER AND PRIMARY CIRCUIT PIPEWORK FOR THE BEZNAU STATION. Straub, H. Sulzer Tech. Rev.; 52: No. 1, 36-44(1970).

A brief description is given of the pressurizer and primary cooling circuit piping. Mention is made of certain aspects and features of the design, fabrication, testing and erection. (auth)

Operation and Economics

Refer also to abstract 6846.

7933 (AECOP-561) ISOTOPE PRODUCTION IN COMMERCIAL POWER REACTORS. Wood, P. M. (Atomic Energy Commission Combined Operations Planning, Oak Ridge, Tenn.). 18 Sep 1970. Contract W-7405-eng-26. 14p. (CONF-700608-22). Dep. NTIS.

From American Nuclear Society Meeting, Los Angeles, Calif.

The present status and future potential of producing large quantities of radioisotopes in light water power reactors are discussed. Some of the economics and difficulties involved in isotope production are examined. Projections of neptunium-237, plutonium-238, and transplutonium isotope production through 1980 are presented. (H.D.R.)

7934 (DOCKET-50010-74) DRESDEN NUCLEAR POWER STATION, UNIT 1. Crack in Primary Piping System Nipple. (Commonwealth Edison Co., Chicago, Ill.). 17 Dec 1970. 2p. Dep. NTIS.

7935 (DOCKET-50130-6) PATHFINDER GENERATING PLANT, SIOUX FALLS, SOUTH DAKOTA. License No. DPR-11. Six Month Operating Report No. 9. Plant Operating Experience, May 15-November 14, 1970. (Northern States Power Co., Minneapolis, Minn.). 2 Dec 1970. 8p. (NSP-7002). Dep. NTIS.

7936 (DOCKET-50171-59) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 3, May 1966. (Philadelphia Electric Co., Pa.). May 1966. 17p. Dep. NTIS.

7937 (DOCKET-50171-60) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 4, June 1966. (Philadelphia Electric Co., Pa.). Jun 1966. 13p. Dep. NTIS.

7938 (DOCKET-50171-61) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 5, July 1966. (Philadelphia Electric Co., Pa.). Jul 1966. 14p. Dep. NTIS.

7939 (DOCKET-50171-62) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 6, August 1966. (Philadelphia Electric Co., Pa.). Aug 1966. 14p. Dep. NTIS.

7940 (DOCKET-50171-63) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 7, September 1966. (Philadelphia Electric Co., Pa.). Sep 1966. 14p. Dep. NTIS.

7941 (DOCKET-50171-64) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 8, October 1966. (Philadelphia Electric Co., Pa.). Oct 1966. 15p. Dep. NTIS.

7942 (DOCKET-50171-65) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 9, November 1966. (Philadelphia Electric Co., Pa.). Nov 1966. 14p. Dep. NTIS.

7943 (DOCKET-50171-66) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 10, December 1966. (Philadelphia Electric Co., Pa.). Dec 1966. 15p. Dep. NTIS.

7944 (DOCKET-50171-67) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 11, January 1967. (Philadelphia Electric Co., Pa.). Jan 1967. 30p. Dep. NTIS.

7945 (DOCKET-50171-68) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 12, February 1967. (Philadelphia Electric Co., Pa.). Feb 1967. 20p. Dep. NTIS.

7946 (DOCKET-50171-69) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 13, March 1967. (Philadelphia Electric Co., Pa.). Mar 1967. 27p. Dep. NTIS.

7947 (DOCKET-50171-70) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 14, April 1967. (Philadelphia Electric Co., Pa.). Apr 1967. 17p. Dep. NTIS.

7948 (DOCKET-50171-71) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 15, May 1967. (Philadelphia Electric Co., Pa.). May 1967. 29p. Dep. NTIS.

7949 (DOCKET-50171-72) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 16, June 1967. (Philadelphia Electric Co., Pa.). Jun 1967. 18p. Dep. NTIS.

7950 (DOCKET-50171-74) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 56, October 1970. (Philadelphia Electric Co., Pa.). 16 Dec 1970. 15p. Dep. NTIS.

7951 (DOCKET-50213-87) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 70-11, November 1970. (Connecticut Yankee Atomic Power Co., Haddam). 17 Dec 1970. Contract AT(30-1)-3250. 11p. (NYO-3250-54). Dep. NTIS.

7952 (DOCKET-50220-55) NINE MILE POINT NUCLEAR STATION. Semiannual Report of Operation, January 1-June 30, 1970. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 9 Dec 1970. 12p. Dep. NTIS.

7953 (DOCKET-50237-100) DRESDEN NUCLEAR POWER STATION, UNIT 2. Diesel-Generator No. 2/3 Found in Nonperforming Condition for Auto Start. (Commonwealth Edison Co., Chicago, Ill.). 6 Feb 1970. 2p. Dep. NTIS.

7954 (DOCKET-50237-112) DRESDEN NUCLEAR POWER STATION, UNIT 2. Fast Closure Time of the Main Steam Isolation Valve, 203-1C. (Commonwealth Edison Co., Chicago, Ill.). 27 Nov 1970. 2p. Dep. NTIS.

7955 (DOCKET-50237-113) DRESDEN NUCLEAR POWER STATION, UNIT 2. Failure of Sodium Pentaborate Solution to Meet Technical Specifications. (Commonwealth Edison Co., Chicago, Ill.). 30 Nov 1970. 2p. Dep. NTIS.

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7956 (DOCKET-50237-116) DRESDEN NUCLEAR POWER STATION, UNIT 2. Recorder on Main Steam Isolation Valve Reading Five Degrees High. (Commonwealth Edison Co., Chicago, Ill.). 10 Dec 1970. 1p. Dep. NTIS.

7957 (DOCKET-50237-117) DRESDEN NUCLEAR POWER STATION, UNIT 2. Abnormal Occurrence Report: Failure of Main Steam Isolation Valves 1D, 2A, 2B, and 2C to Close on Test. (Commonwealth Edison Co., Chicago, Ill.). 11 Dec 1970. 4p. Dep. NTIS.

7958 (DOCKET-50237-118) DRESDEN NUCLEAR POWER STATION, UNIT 2. Abnormal Occurrence Report: Failure of Electromatic Relief Valve 2-203-3C (2C) to Open During Test. (Commonwealth Edison Co., Chicago, Ill.). 18 Dec 1970. 2p. Dep. NTIS.

7959 (DOCKET-50237-119) DRESDEN NUCLEAR POWER STATION, UNIT 2. Abnormal Occurrence Report: Failure of Control Rod Drive 26-15 (G-4) to Withdraw Past Position 46. (Commonwealth Edison Co., Chicago, Ill.). 18 Dec 1970. 2p. Dep. NTIS.

7960 (DOCKET-50237-120) DRESDEN NUCLEAR POWER STATION, UNIT 2. Control Rod Drive 34-23 (J-6) Declared Inoperable. (Commonwealth Edison Co., Chicago, Ill.). 18 Dec 1970. 3p. Dep. NTIS.

7961 (DOCKET-50237-121) DRESDEN NUCLEAR POWER STATION, UNIT 2. Corrective Actions to Noncompliance Activities. (Commonwealth Edison Co., Chicago, Ill.). 14 Dec 1970. 3p. Dep. NTIS.

7962 (DOCKET-50237-122) DRESDEN NUCLEAR POWER STATION, UNIT 2. Noncompliance Factors Relating to June 5, 1970, Depressurization Incident). (Division of Compliance (AEC), Washington, D. C.). 22 Dec 1970. 6p. Dep. NTIS.

7963 (DOCKET-50245-44) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Failure of Emergency Lube Oil Pump to Reach Required Discharge Pressure in Time. (Millstone Point Co., Wethersfield, Conn.). 4 Dec 1970. 1p. Dep. NTIS.

7964 (DOCKET-50245-45) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Failure of Main Steam Isolation Valve 1-MS-1B to Close. (Millstone Point Co., Wethersfield, Conn.). 25 Nov 1970. 1p. Dep. NTIS.

7965 (DOCKET-50245-47) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence Report No. 5. (Millstone Point Co., Wethersfield, Conn.). 14 Dec 1970. 2p. Dep. NTIS.

During a loss of turbine-generator and offsite power test, the isolation condenser was initiated. The isolation condenser system failed to reset following the initiation. Additional attempts to reset the system and then re-initiate the system failed. Revised limiting conditions for initiating switches and valves are presented. (D.C.C.)

7966 (DOCKET-50245-48) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence Report No. 6: Unanticipated Movement of Main Steam Piping on Test Scram. (Millstone Point Co., Wethersfield, Conn.). 19 Dec 1970. 7p. Dep. NTIS.

7967 (DOCKET-50255-31) PALISADES PLANT. Control Rod Mechanism Drop incident. (Consumers Power Co., Jackson, Mich.). 30 Nov 1970. 3p. Dep. NTIS.

7968 (DOCKET-50261-47) H. B. ROBINSON UNIT NO. 2. Abnormal Occurrence Report: Malfunction of Emergency Diesel Generator "B". (Carolina Power and Light Co., Raleigh, N. C.). 7 Dec 1970. 5p. Dep. NTIS.

7969 (DOCKET-50261-48) H. B. ROBINSON UNIT NO. 2. Failure of Emergency Diesel Generator "A". (Carolina Power and Light Co., Raleigh, N. C.). 16 Dec 1970. 2p. Dep. NTIS.

7970 (TID-25577) GUNDREMMINGEN NUCLEAR POWER PLANT MONTHLY REPORT, DECEMBER 1967. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 65p. (In German). Dep. NTIS.

Operations and maintenance requirements during December 1967 are described. Coolant activity and chemistry measurements are listed. (D.C.C.)

7971 (TID-25578) GUNDREMMINGEN NUCLEAR POWER PLANT MONTHLY REPORT, SEPTEMBER 1970. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 41p. (In German). Dep. NTIS.

Operations and maintenance requirements during September 1970 are described. Coolant activity and chemistry measurements are listed. (D.C.C.)

7972 (TID-25581) SENA NUCLEAR POWER PLANT MONTHLY REPORT, MAY 1970. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-Lez-Givet (France)). 18p. Dep. NTIS.

For the greater part of the month the plant was operated at a net power of 232 MW(e), then from 27 May onwards at a net power of 242 MW(e). From 14 to 26 May operations were disrupted by a series of plant malfunctions affecting the steam generator feed, the main alternator electrical protection gear and the main transformer. Operations and maintenance data are summarized. (H.D.R.)

7973 (TID-25582) SENA NUCLEAR POWER PLANT MONTHLY REPORT FOR JULY 1970. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-Lez-Givet (France)). 36p. Dep. NTIS.

Operations and maintenance requirements during the month of July 1970 are reviewed. Fuel status for the reactor is analyzed. (D.C.C.)

7974 (TID-25583) SENA NUCLEAR POWER PLANT, Monthly Report for April 1970. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 19p. Dep. NTIS.

At the beginning of the month output was limited to 125 MW because of successive outages of the feed pumps for repairs. From 10 April onwards, the power was increased and kept steady until the end of the month at about 225 MW(e). Only a few brief shutdowns are to be noted in April, operation of the plant being on the whole satisfactory. (auth)

7975 (TID-25584) SENA NUCLEAR POWER PLANT, Monthly Report for June 1970. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 23p. Dep. NTIS.

The power plant operated without any noteworthy incident from 1 to 7 June at a net power of 242 to 243 MW(e). On 8 June, when trouble occurred on the grid, the main transformer was damaged (a 220 kV winding burned out), causing immediate shutdown of the plant. As an equivalent transformer has been made available to SENA, and it is expected that service can be resumed early in August. The occasion is being used to perform the most important outstanding work, including repair of the leak at the joint of the turbine HP section. (auth)

7976 (WAPD-MRP-133) PRESSURIZED WATER REACTOR PROJECT. Technical Progress Report, April 26, 1970–July 24, 1970. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT-11-1-GEN-14. 22p. Dep. NTIS.

Plant operations and testing on 3 Shippingport coolant loops continued satisfactorily and the total operating time with PWR-2 Seed 2 was increased to approximately 3500 equivalent full power hours (EFPH). Measured coolant flows in the diagonal seed fuel assemblies decreased by 4½% during the first 11 months of power operation with no net decrease occurring in the last 2 month period. Measured coolant flows at all core locations are in excess of design values. Evaluations of the initial startup and full power operation of PWR-2 Seed 2 and the flux wire irradiations through 1700 EFPH of Seed 2 life were submitted. Physics testing near the most reactive time in Seed 2 life was performed. (auth)

7977 SAFETY-RELATED OCCURRENCES IN JUNE–JULY 1970. Casto, W. R. Nucl. Safety; 11: 499-501(Nov-Dec 1970).

Safety and Siting

7978 (BNWL-SA-3282) NUCLEAR POWER PLANTS AND WATER QUALITY CRITERIA. Nakatani, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 21 May 1970. 21p. (CONF-700425-1). Dep. NTIS.

From Colloquium on Environmental Quality, Richland, Wash.

The thermal discharge problems associated with nuclear power plants are briefly examined. Aspects of the problems discussed include: the source of the waste heat; power needs of the United States; State and Federal water quality standards; and surveys of environmental studies at power plant sites. (H.D.R.)

7979 (CONF-691129-2) NEW JERSEY STATE'S ROLE IN POWER REACTOR SITE APPROVAL. Amato, Charles G. (New Jersey Dept. of Health, Trenton. New Jersey Atomic Energy Council). [1969]. 6p. Dep. NTIS.

From 97th Annual Meeting of the American Public Health Association, Philadelphia, Pa.

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7980 (CONF-700810-41) CONSIDERATIONS AND EVALUATION OF THE RECOMMENDATIONS OF ICRP FOR CONTROL OVER RADIOACTIVITY IN DISCHARGES FROM NUCLEAR POWER PLANTS. Belitskii, A. S.; Turkin, A. D. (Ministerstvo Zdravookhraneniya SSSR, Moscow. Institut Biofiziki); Kozlov, V. M. (Ministerstvo Zdravookhraneniya SSSR, Moscow). [1970]. 13p. (In Russian). (SM-146/7). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

On the basis of national legislative documents on radiation safety in the USSR, both in legislation before 1969 (SP No. 333-60) and in the new norms of radiation protection, the recommendations of the ICRP are considered. On the basis of the recommendations of the ICRP for operational control over radiation conditions, permissible concentrations of radioactive materials in air and water were established in the USSR. The maximum permissible release to the air of radioactive gases and aerosols by the AEC was regulated. The design and operation of atomic power plants in accordance with legislation existing in the USSR guarantee their operational safety. (tr-auth)

7981 (DOCKET-1154-3) BONUS NUCLEAR POWER PLANT. Decommissioning Final Report, Supplement No. 1. (Puerto Rico Water Resources Authority, San Juan). 2 Dec 1970. 1p. Dep. NTIS.

Information on the post-decommissioning surveillance program is presented. (D.C.C.)

7982 (DOCKET-1154-4) BONUS NUCLEAR POWER PLANT. Notification of Byproduct Materials License Requirements. (Division of Reactor Licensing (AEC), Washington, D. C.). 14 Dec 1970. 2p. Dep. NTIS.

7983 (DOCKET-50155-54) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6; Proposed Technical Specifications Change No. 21. (Consumers Power Co., Jackson, Mich.). 15 Dec 1970. 18p. Dep. NTIS.

Proposed technical specifications concerning Reload-F fuel elements are presented. (D.C.C.)

7984 (DOCKET-50155-55) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6; Proposed Technical Specifications Change No. 22. (Consumers Power Co., Jackson, Mich.). 17 Dec 1970. 6p. Dep. NTIS.

Technical specifications relating to the use of Type J-1 fuel elements are presented. (D.C.C.)

7985 (DOCKET-50171-73) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Request for Change in Technical Specifications (No. 13). (Philadelphia Electric Co., Pa.). 15 Dec 1970. 14p. Dep. NTIS.

Revised technical specifications concerning plant operations and personnel responsibilities are presented. (D.C.C.)

7986 (DOCKET-50206-98) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Provisional Operating License No. DPR-13, Technical Specifications Proposed Change No. 5. (Southern California Edison Co., Los Angeles). 9 Dec 1970. 6p. Dep. NTIS.

Revised technical specifications concerning the testing frequency of the reactor coolant flow instrumentation channels are described. (D.C.C.)

7987 (DOCKET-50206-99) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Inspection of Reactor Coolant Pump 'C' Flywheel. (Southern California Edison Co., Los Angeles). 15 Dec 1970. 4p. Dep. NTIS.

7988 (DOCKET-50213-86) CONNECTICUT YANKEE NUCLEAR POWER PLANT. Containment Operation and Testing, May 1967-April 1970. (Connecticut Yankee Atomic Power Co., Westboro, Mass.). 30 Nov 1970. 42p. (YAEC-1048). Dep. NTIS.

7989 (DOCKET-50220-56) NINE MILE POINT NUCLEAR STATION. Petition Requesting Amendment of License, Amendment 4. Technical Supplement to Petition to Increase Power Level, Fourth Addendum. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 22 Dec 1970. 134p. Dep. NTIS.

Requested additional information concerning the performance of the emergency core cooling system is presented. (D.C.C.)

7990 (DOCKET-50237-89) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Information Requested on Reactor Pressure Vessel Welding. (Division of Reactor Licensing (AEC), Washington, D. C.). 21 Dec 1967. 3p. (DOCKET-50249-44). Dep. NTIS.

7991 (DOCKET-50237-90) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Request for Additional Information to Final Safety Analysis Report, Vols. 1 and 2. (Division of Reactor Licensing (AEC), Washington, D. C.). 27 Jun 1968. 15p. (DOCKET-50249-45). Dep. NTIS.

7992 (DOCKET-50237-91) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Request for Additional Information to Final Safety Analysis Report. (Division of Reactor Licensing (AEC), Washington, D. C.). 16 Oct 1968. 10p. (DOCKET-50249-46). Dep. NTIS.

7993 (DOCKET-50237-92) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Request for Information on Cracking in Jet Pump Castings. (Division of Reactor Licensing (AEC), Washington, D. C.). 17 Feb 1969. 1p. (DOCKET-50249-47). Dep. NTIS.

7994 (DOCKET-50237-93) DRESDEN NUCLEAR POWER STATION, UNIT 2. Order Extending Completion Date. (Division of Reactor Licensing (AEC), Washington, D. C.). 1 May 1969. 2p. Dep. NTIS.

7995 (DOCKET-50237-94) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Request for Additional Design Information. (Division of Reactor Licensing (AEC), Washington, D. C.). 19 May 1969. 8p. (DOCKET-50249-48). Dep. NTIS.

7996 (DOCKET-50237-95) DRESDEN NUCLEAR POWER STATION, UNIT 2. Information on Testing Piping. (Commonwealth Edison Co., Chicago, Ill.). 2 Jun 1969. 2p. Dep. NTIS.

7997 (DOCKET-50237-96) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Additional Information on Seismic Design. (Commonwealth Edison Co., Chicago, Ill.). 4 Sep 1969. 2p. (DOCKET-50249-49). Dep. NTIS.

7998 (DOCKET-50237-97) DRESDEN NUCLEAR POWER STATION, UNIT 2. ACRS Report. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). 18 Sep 1969. 8p. Dep. NTIS.

7999 (DOCKET-50237-99) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Quality Assurance and Drywell to Pipe Penetration Bellows. (Commonwealth Edison Co., Chicago, Ill.). 16 Oct 1969. 2p. (DOCKET-50249-51). Dep. NTIS.

8000 (DOCKET-50237-102) DRESDEN NUCLEAR POWER STATION, UNIT 2. Provisional Operating License DPR-19; Technical Specifications Change No. 2. (Division of Reactor Licensing (AEC), Washington, D. C.). 18 Jun 1970. 3p. Dep. NTIS.

Revised boundaries for the secondary containment system are described. (D.C.C.)

8001 (DOCKET-50237-104) DRESDEN NUCLEAR POWER STATION, UNIT 2. Modifications to Proposed Change No. 6 to Appendix A of DPR-19. (Commonwealth Edison Co., Chicago, Ill.). 13 Oct 1970. 2p. Dep. NTIS.

Modifications to inspection procedures and requirements for furnace sensitized stainless steel components are described. (D.C.C.)

8002 (DOCKET-50237-105) DRESDEN NUCLEAR POWER STATION, UNIT 2. Errata Sheet to Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 10 Nov 1969. 2p. Dep. NTIS.

8003 (DOCKET-50237-106) DRESDEN NUCLEAR POWER STATION, UNIT 2. Order Extending Provisional Construction Permit Completion Date. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Nov 1969. 2p. Dep. NTIS.

8004 (DOCKET-50237-114) DRESDEN NUCLEAR POWER STATION, UNIT 2. Semiannual Report No. 1, August 28, 1970, Addendum No. 1. (Commonwealth Edison Co., Chicago, Ill.). 4 Dec 1970. 13p. Dep. NTIS.

Data for the environmental monitoring program during April, May, and June 1970 are presented. (D.C.C.)

8005 (DOCKET-50237-115) DRESDEN NUCLEAR POWER STATION, UNIT 2. Summary Technical Report: Primary Containment Leak Rate Test. (Commonwealth Edison Co., Chicago, Ill.). 9 Dec 1970. 32p. Dep. NTIS.

8006 (DOCKET-50245-43) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Provisional Operating License DPR-21, Proposed Change No. 1 to Appendix A. (Connecticut Light and Power

Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 30 Nov 1970. 8p. Dep. NTIS.

Revised scram trip settings for the fast closure turbine control valve and the high flow isolation condenser line are presented. (D.C.C.)

8007 (DOCKET-50245-46) MILLSTONE NUCLEAR POWER STATION, UNIT 1. License No. DPR-21; Technical Specifications Change No. 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 11 Dec 1970. 2p. Dep. NTIS.

Revised technical specifications concerning limiting safety system settings and isolation condenser line high flow trip level setting are presented. Errata to technical specifications are included. (D.C.C.)

8008 (DOCKET-50247-45) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Detailed Statement on Environmental Considerations. (Division of Reactor Licensing (AEC), Washington, D. C.). 8 Dec 1970. 212p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

8009 (DOCKET-50250-36) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Environmental Report. (Florida Power and Light Co.). 15 Nov 1970. 274p. (DOCKET-50251-34). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

8010 (DOCKET-50255-30) PALISADES PLANT. Control Rod Drive Mechanism Modifications. (Consumers Power Co., Jackson, Mich.). 30 Nov 1970. 6p. Dep. NTIS.

8011 (DOCKET-50255-32) PALISADES PLANT. Containment Building Structural Integrity Test. (Consumers Power Co., Jackson, Mich.). 14 Dec 1970. 153p. Dep. NTIS.

8012 (DOCKET-50266-36) POINT BEACH NUCLEAR PLANT, UNIT 1. Facility Operating License DPR-24, Application for Amendment 1. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). 14 Dec 1970. 3p. Dep. NTIS.

Revised possession and use restrictions for radioactive by-product materials are presented. (D.C.C.)

8013 (DOCKET-50269-29) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 24 (Includes Final Safety Analysis Report, Rev. 14). (Duke Power Co., Charlotte, N. C.). 14 Dec 1970. 158p. (DOCKET-50270-29; DOCKET-50287-26). Dep. NTIS.

Proposed technical specifications are presented. Revised information is included. (D.C.C.)

8014 (DOCKET-50285-38) FORT CALHOUN STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 21 (Includes Final Safety Analysis Report, Suppl. No. 4). (Omaha Public Power District, Nebr.). 3 Dec 1970. 242p. Dep. NTIS.

Revised design parameters of the Fort Calhoun Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

8015 (DOCKET-50286-29) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. Preliminary Safety Analysis Report, Amendment 13 (Includes Final Facility Description and Safety Analysis Report, Exhibit B-12, Vol. 1). (Consolidated Edison Co. of New York, Inc., New York). 4 Dec 1970. 635p. Dep. NTIS.

Information on Indian Point Power Reactor Unit 3 is presented under the broad topic of site and environment. (D.C.C.)

8016 (DOCKET-50286-30) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. Preliminary Safety Analysis Report, Amendment 13 (Includes Final Facility Description and Safety Analysis Report, Exhibit B-12, Vol. 2). (Consolidated Edison Co. of New York, Inc., New York). 4 Dec 1970. 463p. Dep. NTIS.

Information on Indian Point Power Reactor Unit 3 is presented under the following broad topics: reactor; reactor coolant system; and containment. (D.C.C.)

8017 (DOCKET-50286-31) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. Preliminary Safety Analysis Report, Amendment 13 (Includes Final Facility Description and Safety Analysis Report, Exhibit B-12, Vol. 3). (Consolidated Edison Co. of New York, Inc., New York). 4 Dec 1970. 370p. Dep. NTIS.

Information on Indian Point Power Reactor Unit 3 is presented under the following broad topics: engineered safety features; instrumentation and control; and electrical systems. (D.C.C.)

8018 (DOCKET-50286-32) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. Preliminary Safety Analysis Report, Amendment 13 (Includes Final Facility Description and Safety Analysis Report, Exhibit B-12, Vol. 4). (Consolidated Edison Co. of New York, Inc., New York). 4 Dec 1970. 414p. Dep. NTIS.

Information on Indian Point Power Reactor Unit 3 is presented under the following broad topics: auxiliary systems; steam and power conversion; waste disposal and radiation protection; conduct of operations; and initial tests and operations. (D.C.C.)

8019 (DOCKET-50286-33) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. Preliminary Safety Analysis Report, Amendment 13 (Includes Final Facility Description and Safety Analysis Report, Exhibit B-12, Vol. 5). (Consolidated Edison Co. of New York, Inc., New York). 4 Dec 1970. 600p. Dep. NTIS.

Information on Indian Point Power Reactor Unit 3 is presented under the following broad topics: safety analysis; technical specifications; seismic design requirements; and quality assurance program. (D.C.C.)

8020 (DOCKET-50289-29) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 15 (Includes Final Safety Analysis Report Modifications, App. 4A, Suppl. 2). (Metropolitan Edison Co., Reading, Pa. Jersey Central Power and Light Co., Morristown, N. J.). 16 Dec 1970. 587p. Dep. NTIS.

Revised design parameters of the Three Mile Island Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

8021 (DOCKET-50295-20) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 12 (Includes Final Safety Analysis Report, Vol. 5). (Commonwealth Edison Co., Chicago, Ill.). 1 Dec 1970. 177p. (DOCKET-50304-20). Dep. NTIS.

Information on Zion Power Reactor Units 1 and 2 is presented under the following broad topics: steam and power conversion; waste disposal and radiation protection; conduct of operations; and initial tests and operations. (D.C.C.)

8022 (DOCKET-50295-21) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 12 (Includes Final Safety Analysis Report, Vol. 6). (Commonwealth Edison Co., Chicago, Ill.). 1 Dec 1970. 500p. (DOCKET-50304-21). Dep. NTIS.

Safety analysis for the Zion Power Reactor Units 1 and 2 is presented. Potential accident conditions and operation incidents are analyzed. (D.C.C.)

8023 (DOCKET-50309-26) MAINE YANKEE ATOMIC POWER STATION. Preliminary Safety Analysis Report, Amendment 17. (Maine Yankee Atomic Power Co., Westboro, Mass.). 14 Dec 1970. 119p. Dep. NTIS.

Revised design parameters and additional information related to the Maine Yankee Power Reactor are presented. (D.C.C.)

8024 (DOCKET-50315-25) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Status Report, December 5, 1970. (American Electric Power Service Corp., New York). 8 Dec 1970. 30p. (DOCKET-50316-25). Dep. NTIS.

Information on Donald C. Cook Power Reactor Units 1 and 2 is presented under the following headings: ice condenser removal of iodine; hydrogen generation; common mode failure; environmental monitoring program; meteorology program; and in-service inspection. (D.C.C.)

8025 (DOCKET-50331-24) DUANE ARNOLD ENERGY CENTER. Preliminary Safety Analysis Report, Amendment 16. (Iowa Electric Light and Power Co., Cedar Rapids). 7 Dec 1970. 32p. Dep. NTIS.

Additional information concerning the emergency cooling-water systems is presented. Flow and temperature characteristics of the Cedar River are described. (D.C.C.)

8026 (DOCKET-50336-21) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Construction Permit No. CPPR-76. (Division

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of Reactor Licensing (AEC), Washington, D. C.). 11 Dec 1970. 5p. Dep. NTIS.

8027 (DOCKET-50341-22) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 14. (Detroit Edison Co., Mich.). 21 Dec 1970. 37p. Dep. NTIS.

The 1969 Annual Report for the Detroit Edison Company is presented. (D.C.C.)

8028 (DOCKET-50341-23) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 12-A. (Detroit Edison Co., Mich.). 22 Dec 1970. 117p. Dep. NTIS.

Revised design parameters of the Fermi Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

8029 (DOCKET-50352-10) LIMERICK GENERATING STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 3, Suppl. 3. (Philadelphia Electric Co., Pa.). 11 Dec 1970. 82p. (DOCKET-50353-10). Dep. NTIS.

Revised design parameters of the Limerick Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

8030 (DOCKET-50358-9) WM. H. ZIMMER NUCLEAR POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 3. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 15 Dec 1970. 206p. (DOCKET-50359-8). Dep. NTIS.

Revised design parameters and additional information on the William H. Zimmer Power Reactor Units 1 and 2 are presented under the following main headings: containment system; stress limits for structures; shielding; and quality assurance program. (D.C.C.)

8031 (DOCKET-50361-12) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Amendment 4. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 21 Dec 1970. 573p. (DOCKET-50362-11). Dep. NTIS.

Revised design parameters of the San Onofre Power Reactor Units 2 and 3 are presented. Included also are additional data requested by the Division of Reactor Licensing. (D.C.C.)

8032 (DOCKET-50363-9) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 3. (Jersey Central Power and Light Co., Morristown, N. J.). 15 Dec 1970. 17p. Dep. NTIS.

Requested information concerning design specifications and operating limits for 3390 MW(t) and 2440 MW(t) cores is presented. (D.C.C.)

8033 (DOCKET-50366-7) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 1. (Georgia Power Co., Atlanta). 22 Dec 1970. 43p. Dep. NTIS.

Revised design parameters and additional information related to the Edwin I. Hatch Power Reactor Unit 2 are presented. (D.C.C.)

8034 (DOCKET-50368-6) ARKANSAS NUCLEAR ONE, UNIT 2. Preliminary Safety Analysis Report, Suppl. 1. (Arkansas Power and Light Co., Little Rock). 11 Dec 1970. 142p. Dep. NTIS.

Revised design parameters and additional information related to the Arkansas Nuclear One Power Reactor Unit 2 are presented. (D.C.C.)

8035 (DOCKET-50369-5) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Duke Power Co., Charlotte, N. C.). 22 Dec 1970. 172p. (DOCKET-50370-4). Dep. NTIS.

Revised design parameters and additional information related to the McGuire Power Reactor Units 1 and 2 are presented. (D.C.C.)

8036 (DOCKET-50376-1) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Environmental Statement. (Puerto Rico Water Resources Authority, San Juan). 28 Nov 1970. 102p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

8037 (DOCKET-50376-2) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Application for License. (Puerto Rico Water Resources Authority, San Juan). 28 Nov 1970. 79p. Dep. NTIS.

Financial data on the owners of the Aguirre Power Reactor Unit 1 are presented in support of the application for construction permit and operating license. The 1968 to 1969 Annual Report for the Puerto Rico Water Resources Authority is included. (D.C.C.)

8038 (DOCKET-50376-3) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Preliminary Facility Description and Safety Analysis Report, Vol. 1. (Puerto Rico Water Resources Authority, San Juan). 28 Nov 1970. 421p. Dep. NTIS.

Information on Aguirre Power Reactor Unit 1 is presented under the following broad topics: introduction and summary; site; reactor; and reactor coolant system. (D.C.C.)

8039 (DOCKET-50376-4) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Preliminary Facility Description and Safety Analysis Report, Vol. 2. (Puerto Rico Water Resources Authority, San Juan). 28 Nov 1970. 449p. Dep. NTIS.

Information on Aguirre Power Reactor Unit 1 is presented under the following broad topics: containment system; engineered safeguards; instrumentation and controls; electrical systems; auxiliary and emergency systems; and steam and power conversion system. (D.C.C.)

8040 (DOCKET-50376-5) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Preliminary Facility Description and Safety Analysis Report, Vol. 3. (Puerto Rico Water Resources Authority, San Juan). 28 Nov 1970. 400p. Dep. NTIS.

Information on Aguirre Power Reactor Unit 1 is presented under the following broad topics: radioactive waste and radiation protection; conduct of operations; initial tests and operation; safety analysis; and technical specifications. (D.C.C.)

8041 (DOCKET-50376-6) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Preliminary Facility Description and Safety Analysis Report, Vol. 4. (Puerto Rico Water Resources Authority, San Juan). 28 Nov 1970. 370p. Dep. NTIS.

Information on Aguirre Power Reactor Unit 1 is presented under the following headings: geological data for the reactor site; meteorological data for the reactor site; cooling system radioactivity; turbine generator missiles; dose calculations for standby safeguards analysis; and quality assurance program. (D.C.C.)

8042 NUCLEAR SAFETY. VOLUME 11, NUMBER 6. Cottrell, Wm. B.; Blakely, J. P.; Jordan, W. H.; Savolainen, A. W. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (Nov-Dec 1970). 105p. GPO $0.60.

Articles are presented on nuclear safety under the following headings: General Safety Considerations; Accident Analysis; Control and Instrumentation; Consequences of Effluent Release; Operating Experiences; and Current Events. A separate abstract is prepared for each of the 9 articles presented. (D.C.C.)

For abstracts of individual papers see: 6707, 6808, 7788, 7977, 8043–8046, and 8109.

8043 SYSTEMS APPROACH TO NUCLEAR PLANT SAFETY. Snedeker, J. Thomson (General Electric Co., Pleasanton, Calif.). Nucl. Safety; 11: 445-9(Nov-Dec 1970).

The complexity and advanced technology of today's nuclear plants warrant a new look at nuclear plant safety. The evaluation technique advanced is based on defining the events for which a nuclear plant must be designed and then specifying the unacceptable consequences of those events. It is then possible to systematically analyze the plant to identify the actions, systems, and components essential to accommodating the specified events so that unacceptable results are not obtained. The actions, systems, and components identified as essential must then be designed and operated in such a way that specified standards of redundancy and quality are maintained. In this way plant design and operation reflect a comprehensive and consistent balance with respect to nuclear safety. (auth)

8044 INSTRUMENTATION FOR MONITORING THE HYPOTHETICAL LOSS-OF-COOLANT ACCIDENT IN LARGE LIGHT-WATER POWER REACTORS. Robinson, T. G.; Duggins, B. C. Nucl. Safety; 11: 468-74(Nov-Dec 1970).

Various engineered safety features available in nuclear-fueled commercial power stations would be called upon to cope with the consequences of a loss-of-coolant accident. These safety features are provided with instruments to initiate operation and to monitor continued operation. When the safety features are called upon, the plant operator needs information regarding both the operation of these emergency systems and equipment and the continuing performance. The types and extent of instrumentation available in the designs of representative nuclear power plants of the latest gen-

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eration for monitoring the course of a loss-of-coolant accident are described. The four plants surveyed appear to have adequate and sufficient instrumentation for monitoring the operation of the equipment in the engineered safety system for the case of a successfully contained loss-of-coolant accident; however, instruments for directly detecting unexpected damage to the reactor core appear to be lacking. 18 references. (auth)

8045 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. Nucl. Safety; 11: 503-13(Nov-Dec 1970).

8046 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. Nucl. Safety; 11: 517-35(Nov-Dec 1970).

Steam and Power Conversion Systems

Refer also to abstract 6502.

Power Reactor Development

Refer also to abstracts 6855, 6915, and 8115.

8047 (ANL-7753) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, OCTOBER 1970. (Argonne National Lab., Ill.). 24 Nov 1970. Contract W-31-109-eng-38. 171p. Dep. NTIS.

Highlights of project activities for October 1970 are summarized. LMFBR physics development and component development are reviewed. Operations and analysis of ZPR-3, ZPR-6, ZPR-9, and ZPPR are described. The EBR-2 research and development projects, fuel development, and operations are summarized. Reactor fuels and materials development, physics studies, engineering development, fuel cycle chemistry, and LMFBR safety studies are reported. (D.C.C.)

8048 (EURFNR-825) ACTIVITY REPORT OF 1968. PART I. DESIGN STUDIES ON THE REFERENCE PLANT. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). 127p. (In Italian). Dep. NTIS (U. S. Sales Only).

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The activities of the CNEN during 1968 in the design and development of a sodium cooled fast reactor are summarized. Part I contains a technical-economic evaluation of the reactor, safety aspects, reactor core design, and descriptions of the plant components and systems. (H.D.R.)

8049 (EURFNR-829) ACTIVITY REPORT OF 1968. PART V. PLANNING AND SCHEDULING. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). 26p. (In Italian). Dep. NTIS (U. S. Sales Only).

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Activities planned in the CNEN program for the development of a sodium cooled fast reactor are summarized. The scheduling of projects in reactor physics, reactor engineering, administrative aspects, computer program usage, documentation, and kinetics and dynamics calculations is briefly presented. (H.D.R.)

8050 (GA-10288) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending August 31, 1970. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Sep 1970. Contract AT(04-3)-167. 57p. Dep. NTIS.

CESIUM-134—diffusion in graphite, (T)
CESIUM-137—diffusion in graphite, (T)
GRAPHITE—diffusion of cesium-134 and cesium-137 in, (T)
—radiation effects on dimensional stability of, neutron, (E)
HIGH TEMPERATURE LATTICE TEST REACTOR—physics parameters of HTGR lattice in, (E)
NEUTRONS—effects on dimensional stability of graphite, (E)
REACTOR FUEL ELEMENTS—reprocessing cycle development for gas cooled
—fabrication of coated particle type gas cooled, for recycle testing
REACTOR FUELS—radiation effects testing of coated particle
—reprocessing of coated particle, fluid bed oxidation procedures in, (E)
REACTORS, GAS COOLED—development of 1000 MW(e) HTGR concept during June through August 1970
—fission product release and transport in high temperature, (E/T)
—fuel elements for high temperature, fabrication and irradiation testing of recycle, (E/T)
—fuel elements for high temperature, plant designs and costs for reprocessing
REACTORS, POWER—development of 1000 MW(e) HTGR concept during June through August 1970
STRONTIUM—vaporization from graphite, (E) (H.D.R.)

8051 (KFK-1238) OPTIMIZING SODIUM-COOLED FAST-BREEDER REACTORS BY THE METHODS OF NONLINEAR PROGRAMING. Heusener, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Jul 1970. 109p. (In German). Dep. NTIS (U. S. Sales Only).

Methods of nonlinear programming are used to optimize fast breeder reactors. Two different procedures, a systematic one (method of steepest descent) and a statistical one (evolution strategy), are described. Their advantages and disadvantages are discussed. As example for the application of these methods, a core optimization for sodium cooled 1000 MW(e) breeder reactors with oxide and carbide fuel is considered. In order to reduce the needed computer time, approximations in nuclear computations are necessary. A procedure is described which allows a fast and sufficiently accurate estimation of the nuclear results. The optimization is performed with regard to two different criteria. The resulting design characteristics are discussed. Using importance quantities, which are obtained as part of the solution, the influence of the design limits upon the optimization criterion is predicted quantitatively. By recalculating some special cases the reliability of the predictions is demonstrated. (49 references) (auth)

Kinetics and Dynamics

8052 (AEEW-M-975) MEASUREMENT OF THE CALIBRATION FACTOR $P(\epsilon,t)$ FOR FAST-FISSION RATIO MEASUREMENTS IN MK III GAS-COOLED REACTOR FUEL ELEMENTS. Taylor, W. H.; De Lapparent, D. (Atomic Energy Establishment, Winfrith (England)). Jan 1970. 13p. Dep. NTIS (U. S. Sales Only).

The calibration factor $P(\epsilon,t)$, (which has previously been used to convert the ratio of fission product γ-ray activity, induced in circular foils containing U^{238} and ^{235}U, to a fission rate ratio) has been remeasured using foils, shaped as a sector of an annulus, which will be used to determine the Fast Fission Ratio in the annular fuel region of a Mk. III GCR fuel element. (auth) (UK)

8053 (AI-AEC-12978) LMFBR PHYSICS PROGRAMS. Quarterly Technical Progress Report, July-September 1970. (Atomics International, Canoga Park, Calif.). 12 Nov 1970. Contract AT(04-3)-701. 39p. Dep. NTIS.

CRITICAL ASSEMBLIES—reactivity worth measurements in ECEL cores 17 and 18
LIQUID METAL FAST BREEDER REACTOR—physics measurement programs during July to September 1970
REACTOR CONTROL ELEMENTS—reactivity worth measurements on tantalum, in fast reactor spectra
REACTORS, FAST—physics calculations for, development of VIM-1 code for
TANTALUM ISOTOPES—neutron cross sections for, evaluation of, (E/T)
TUNGSTEN ISOTOPES—neutron cross sections for, evaluation of, (E/T)
URANIUM OXIDES UO_2—Doppler coefficient measurements in fast reactor spectra (H.D.R.)

8054 (ANL-EBR-20) EBR-II CODES FOR PROCESSING REACTIVITY DATA AT FULL AND REDUCED COOLANT FLOWS. EBR-II Project. Long, J. K.; Dean, E. M. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). May 1970. Contract W-31-109-eng-38. 45p. Dep. NTIS.

Comparing measurements of power-reactivity decrements (PRD) at full and reduced coolant flows requires that corrections be applied for thermal expansion of the bank of control-rod handles, bulk-sodium temperature, fuel burnup, flow variations, control-rod calibrations, and several instrument calibrations. Computerized methods for calculating these corrections in a uniform and orderly manner were developed. The sequence of calculations is: determination of control-rod worths; determination of rod-bank position; correction for effects of thermal expansion of control-rod handles; determination of reactor power, position of control rods, and PRD for a control-rod configuration; and determination of an effective thermal-expansion parameter of fuel from data for reduced coolant flows. This parameter is an effective average expansion coefficient for driver and experimental fuels in the core. 8 references. (auth)

8055 (BNWL-SA-3093(Vol.1), pp VIII.1-15) PRINCIPAL REACTIVITY COEFFICIENTS. Little, W. W. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume I. Safety practices and background information.

The sodium voiding, Doppler resonance broadening, and structural expansion reactivity effects in fast reactors are briefly described. Reactivity coefficients for various fast reactors are tabulated. (H.D.R.)

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8056 (KFK-1180) INFLUENCE OF THE METHOD OF CALCULATION ON THE MULTIPLICATION FACTOR K_{eff} AND THE VOID EFFECT Δk_V FOR A LARGE FAST SODIUM-COOLED BREEDER REACTOR. Schroeter, K. E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Apr 1970. 233p. (In German). Dep. NTIS (U.S. Sales Only).

The uncertainties associated with the nuclear parameters for large fast reactors are due to uncertainties in the nuclear data and calculational methods. For a standard system the influence of different calculational methods on the multiplication factor k_{eff} and the void effect Δk_V is analyzed. After an analysis of the void effect (dependence on the reaction types, energy and space) the influence of changes in macroscopic cross sections on K_{eff} and Δk_V is investigated and explained. This results in a method of anticipating changes in the void effect for specific changes of the system. These preconditions will allow an explanation of the influence of the methods considered. The resulting corrections for k_{eff} and Δk_V are summarized in two tables. Depending on the compilation of individual corrections, total corrections for k_{eff} are obtained ranging from 2.1% to 2.94% and for Δk_V from 36% to 20%. 91 references. (auth)

8057 (NP-18548) SPATIAL XENON INSTABILITY IN THERMAL REACTORS. Report 6910. Olsson, Gustaf (Lund Inst. of Tech. (Sweden). Div. of Automatic Control). Jul 1969. 91p. Dep. NTIS (U. S. Sales Only).

Xenon spatial oscillations in cylindrical thermal water reactors have been analyzed with several different models. The fundamentals of the problem are discussed and different mathematical models are described. The nature of the oscillations makes it possible to approximate the axis of the reactor core with only two points. This two point model gives a good physical insight into the problem and is shown to be rather accurate. The linearized two point model can be treated analytically, and the influence of different parameters are compared with more complex models. The partial differential equation has also been approximated by several meshpoints in space. Calculations show how the critical values of the parameters vary with the number of meshpoints. The nonlinear two point model has predicted unstable and stable periodic solutions, which have been verified by simulation of a more complex nonlinear model. If a control rod is used to maintain criticality, it is shown that the rod does not affect linear stability in some cases. The nonlinear behavior is, however, very much influenced by the rod. The temperature feedback has also a big influence on linear stability as well as nonlinear behavior. 24 references. (auth) (Sweden)

8058 (TRG-Report-2060) COMPUTATION OF ASYMMETRIC POWER DIVERGENCES IN LARGE NUCLEAR REACTORS. Thornton, D. E. J. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1970. 23p. (CONF-701019-1). Dep. NTIS (U. S. Sales Only).

From CREST Meeting on Reactivity Effects in Large Power Reactors, Ispra, Italy.

A method is described for calculating the course of rapid asymmetrical power divergences in large nuclear reactors without a specially written multi-dimensional kinetics computer code. The computer codes used are a steady-state two-dimensional azimuthal-plane flux and reactivity code and a one-dimensional axial kinetics code. An example is given of the application of the method to a control-rod withdrawal fault in the Advanced Gas-Cooled Reactor, and the validity of the method is discussed. (auth) (UK)

8059 STATUS OF REACTOR-PHYSICS CALCULATIONS FOR U. S. POWER REACTORS. Chernick, Jack (Brookhaven National Lab., Upton, N. Y.). Reactor Technol.; 13: 368-86 (Winter 1970-1971).

The evolution of some of the codes used in reactor-physics design is examined. The many additional codes needed for studies of reactor-plant dynamics, control, and safety, shielding studies, fuel-depletion or fuel-management studies, and the LMFBR are discussed. Nuclear data or integral experiment data needed as input into these codes, the theoretical developments that underlie the present codes, and the directions for future improvements in accuracy or costs are described. 158 references. (H.D.R.)

8060 SODIUM-COOLED REACTORS: RAPSODIE PHYSICS ASPECTS. Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Technol.; 13: 340-54(Winter 1970-1971).

The results of the physics tests on the initial core of Rapsodie are discussed. For discussion purposes the tests are divided into two groups: (1) basic physics (neutronics) characteristics and (2) integral physics parameters that relate to reactor operation. The first group consists of neutron fission- and capture-rate distributions, neutron fluxes and spectra, and gamma heating rates; the second group includes isothermal temperature coefficients of reactivity, power coefficients of reactivity, and rod calibrations. 5 references. (auth)

Control Systems

8061 DESIGN AND TESTING OF AN INCORE IONIZATION CHAMBER. Mayer, W. (Allgemeine Elektricitaets-Gesellschaft Telefunken, Grosswelzheim, Ger.). Kerntechnik; 12: 388-92 (Sep 1970). (In German and English).

A definition of all the requirements imposed on an incore ionisation chamber is followed by a discussion of how such a chamber should be designed in order to satisfy these requirements. Ionisation chambers with a hollow cylindrical inner electrode and with a linear signal up to a neutron flux density of 1.2×10^{14} cm^{-2} s^{-1} have been built for use in boiling water reactors. This linear performance was confirmed by experiments in the reactor FRJ-1. The measured neutron and gamma sensitivities of 1.6×10^{-17} A/cm^{-2} s^{-1} and 1.2×10^{-14} A/Rh^{-1} respectively were also in agreement with the expectations. (auth)

Shielding

8062 (BNWL-SA-3093(Vol.1), pp V.1-33) SHIELDING FUNDAMENTALS. Bunch, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume I. Safety practices and background information.

The basic characteristics of radiations and their interactions with matter are reviewed. Procedures for calculations on the shielding of photons and neutrons are examined, and radiation sources and shielding criteria for fast reactors are discussed. (H.D.R.)

8063 (CEA-N-1384) COSANI PROGRAM: THE COMPARISON OF SEVERAL RESULTS FROM THE SABINE AND ANISN PROGRAMS. Dupont, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1970. 11p. (In French). Dep. NTIS (U. S. Sales Only).

Using the COSANI program (COmparison between SAbine and ANIsn) comparisons may be made on the same BENSON graph of the results of one or several SABINE and/or ANISN calculations from the output tapes. The program compares uncorrected results of SABINE and/or ANISN. Normalization factors must be introduced as input data, if a direct comparison by the COSANI code is to be made. (auth) (France)

Cooling Systems

Refer also to abstract 6585.

8064 (ANL-7740) AN EXPERIMENTAL STUDY OF LOW-QUALITY, STEAM-WATER CRITICAL FLOW AT MODERATE PRESSURES. Henry, Robert E. (Argonne National Lab., Ill.). Sep 1970. Contract W-31-109-eng-38. 23p. Dep. NTIS.

Data for two-phase, steam-water critical flow were obtained in a long, constant-area duct. The ranges of parameters studied were flow rates from 1649 to 6603 $lb_m/sec\text{-}ft^2$, exit pressures from 150 to 300 psia, and thermodynamic-equilibrium qualities from 0.0030 to 0.1467. The data exhibit the same general trends as previously published low-pressure (40 to 150 psia) experimental results, and they are also in good agreement with a correlation derived from the low-pressure data. 14 references. (auth)

8065 (BNWL-SA-3427) PRESSURE VESSELS FOR NUCLEAR REACTORS. Bush, S. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 30 Jun 1970. 39p. (CONF-700934-2). Dep. NTIS.

From 2nd International Conference on the Science of Materials, Tremezzo, Italy.

The design, fabrication, and properties of pressure vessels for various reactor concepts are reviewed. Pressure vessel types examined are: (1) heavy-walled ferritic steel vessels used for boiling water and pressurized water reactors; (2) prestressed concrete reactor vessels; and (3) thin-walled austenitic stainless steel vessels for liquid metal cooled fast reactors. 16 references. (H.D.R.)

8066 (DP-Report-433) DESIGN, PRINCIPLE OF CALCULATION, AND EXPERIMENTAL RESULTS FOR THE HELIUM PURIFICATION PLANTS USED IN THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Walravens, M. J. (Atomic Energy Establishment, Winfrith (England)). May 1966. 171p. Dep. NTIS.

The helium purification process used in the Dragon Reactor Experiment is described and a few principles of the calculation are produced. The results obtained during the official acceptance tests carried out on the three plants are reviewed. It appears that the plants as designed by the Project are able to achieve and maintain an extremely high level of outlet helium purity. (auth)

8067 (DP-Report-449) GRAPHITE CORROSION AND RADIOLYSIS OF CARBON DIOXIDE IN THE IN-PILE CARBON TRANSPORT LOOP. Project DRAGON. Burkholz, A.; Kinsey, D. V. (Atomic Energy Establishment, Winfrith (England)). Aug 1966. 25p. Dep. NTIS.

A theoretical explanation is presented for graphite corrosion and gas irradiation results from an in-pile carbon transport test loop. The effects of radiation on the CO_2–graphite reaction are analyzed. The radiolysis of CO_2 is discussed. 12 references. (D.C.C.)

8068 (DP-Report-479) PRACTICAL APPLICATION OF THEORETICAL STUDIES TO THE TILTING-PAD GAS BEARING. Project DRAGON. Corniglion, J. (Atomic Energy Establishment, Winfrith (England)). Sep 1966. 17p. Dep. NTIS.

The theory for gas lubrication where its application has been extended to the pivoted pad is compared with experimental findings. A choice of pad to fulfil a certain design requirement is described. 5 references. (auth)

8069 (EURFNR-828) ACTIVITY REPORT OF 1968. PART IV. DEVELOPMENT OF THE SODIUM CIRCUIT COMPONENTS. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). 182p. (In Italian). Dep. NTIS (U. S. Sales Only).

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The CNEN activities on the development of the sodium cooling system for a sodium cooled fast reactor reference plant are summarized. Separate sections discuss the overall power plant concept, the design of sodium circuit components, mathematical techniques used in the design, sodium–water reactions, dynamic analysis of sodium components, and supporting studies. (H.D.R.)

8070 (WAPD-TM-918) THERMAL AND HYDRAULIC EFFECTS OF CRUD DEPOSITED ON ELECTRICALLY HEATED ROD BUNDLES (LWBR DEVELOPMENT PROGRAM). Green, S. J.; LeTourneau, B. W.; Peterson, A. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sep 1970. Contract AT(11-1)-Gen-14. 85p. Dep. NTIS.

Critical Heat Flux (CHF) and pressure drop tests were performed on four electrically heated 20-rod bundles, using three different rod support systems. The rod bundles were artificially crudded by injection of $Fe(OH)_2$ slurry into the loop containing the heated rod bundle. No effect of crud on CHF was noted at crud levels sufficient to cause up to 100% increase in isothermal pressure drop, most of the crud having been preferentially deposited at the support grids. No very large wall temperature increases were observed due to the crud thermal resistance. An anomalous inlet region failure which occurred during one of the tests is attributed to electrical and mechanical peculiarities of the test section rather than to the crud. (auth)

8071 SODIUM PIPING FOR THE LMFBR. Simons, E. M. (Battelle Memorial Inst., Columbus, Ohio). Reactor Technol.; 13: 321-39(Winter 1970-1971).

Conceptual designs of 1000-MW(e) LMFBRs call for primary-system sodium piping up to 48 in. in diameter and maximum sodium temperatures in the neighborhood of 1200°F (650°C). Considerations regarding sodium-piping technology in relation to the requirements of full-scale LMFBR systems are presented. Included are some highlights of the proposed guide. 14 references. (auth)

8072 WATER SEPARATORS AND REHEATERS IN NUCLEAR POWER STATIONS. Grotloh, Kh. Sulzer Tech. Rev.; 52: No. 1, 30-5(1970).

Combined water separators and reheaters for nuclear power plant circuits, with the purpose of reducing the steam wetness for the low-pressure turbine stages so that losses and blade erosion become comparable with normal reheat turbines are examined. Design and mode of operation leading to optimized water separation and reheating are discussed. (auth)

Fuels

Refer also to abstracts 6491, 6507, 6509–6511, and 8052.

8073 (ANL-7676) SYMPTOMS AND DETECTION OF A FISSION-PRODUCT RELEASE FROM AN EBR-II FUEL ELEMENT. CASE 2. DEFECT BELOW FUEL ELEVATION. EBR-II Project. Fryer, R. M.; Smith, R. R.; Ebersole, E. R.; Strain, R. V. (Argonne National Lab., Ill.). Jun 1970. Contract W-31-109-eng-38. 38p. Dep. NTIS.

Experience in EBR-II with a fuel element having a defect at the lower end brought an increased ability to identify the type of defect by interpreting the response from fission-product monitors. The defect covered became apparent when, during a reactor shutdown on December 24, 1968, a fission-product release occurred after pump shutdown. The source of leakage (subassembly C2008) was identified by correlating the timing of subsequent releases with routine changes in core loading. Before the identification was made, analysis had shown that the source must be a driver-fuel element with a defect near the lower end. This conclusion was confirmed by postirradiation examination. The "fingerprint" of this particular type of leaker is easily distinguishable from that of releases through flaws at other elevations along a fuel element. This experience, coupled with experience from previous EBR-II leakers, allowed a definition of failure types to be proposed. The character of the responses from the three fission-product monitoring systems is shown to be a function of the historical origin and the elevation of the flaw. The irradiation of this type of leaker to 1.0 at. % burnup provided further proof of the inherent safety in the design of the EBR-II fuel element. The safe operation of EBR-II was not compromised by the presence of this leaker in the core. 8 references. (auth)

8074 (EURFNR-827) ACTIVITY REPORT OF 1968. PART III. FUEL ELEMENT DEVELOPMENT. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). 226p. (In Italian). Dep. NTIS (U. S. Sales Only).

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The CNEN activities on the development of uranium dioxide fuel elements for sodium cooled fast reactors are summarized. Materials properties studies, fabrication procedures, irradiation testing projects, supporting studies on project activities, and the PEC fast test reactor fuel element development are discussed. (H.D.R.)

8075 (IN-1428) PARTICLE SIZE DISTRIBUTIONS FROM FUEL RODS FRAGMENTED DURING POWER BURST TESTS IN THE CAPSULE DRIVER CORE. McClure, J. A. (Idaho Nuclear Corp., Idaho Falls). Oct 1970. Contract AT(10-1)-1230. 115p. Dep. NTIS.

Particle distributions obtained from individual fuel rods fragmented during rapid power bursts in the Capsule Driver Core (CDC) are shown to follow a log-normal frequency distribution in weight percent versus the particle size. The parameters for each distribution are given and their correlation with energy deposition in the fuel and with rod design is examined. Evidence is given to show that the distributions do not shift indefinitely toward smaller particle sizes with increasing energy density but approach an asymptotic distribution. The fuel rod design influences the particle distributions near the fragmentation threshold. (6 references) (auth)

8076 (GA-9715) USE OF LOW ENRICHMENT URANIUM IN THE HTGR. Southworth, B. W.; Lee, D. H. Jr.; Dahlberg, R. C. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Sep 1970. Contract AT(04-3)-167. 79p. Dep. NTIS.

The study of low enrichment fuel cycle is divided into three phases in which fuel elements of different geometry are used to reduce the resonance integral of ^{238}U and thereby the enrichment requirements. The first phase concerns the original fuel element design for the Fort St. Vrain Power Reactor. The second phase pertains to a modified Fort St. Vrain Power Reactor fuel element. The third phase relates to an extensively modified fuel element. Economics for annual and semiannual refueling are compared. (8 references) (D.C.C.)

Auxiliary and Emergency Systems

8077 (BNWL-SA-3093(Vol.2), pp XIII.1-29) REACTOR PROTECTION SYSTEMS. Fies, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

The components and individual systems which make up the plant protection system are defined. Basic requirements of a protection system are described, and methods for analyzing the probability of protection system failure are discussed. (7 references) (H.D.R.)

8078 (BNWL-SA-3093(Vol.2), pp XIV.1-39) PROTECTIVE INSTRUMENTATION. Peterson, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

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From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

Instrumentation which functions in a safety capacity in the FFTF is examined. The types of protection, the criteria, and the sensors involved are discussed. (H.D.R.)

Operation and Economics

8079 (BMBW-FBK-70-18) HIGH-PRESSURE CYCLE FOR CO_2 WITH A SUPERCRITICAL BASE PRESSURE COMBINED WITH A SODIUM-COOLED FAST BREEDER (Na/CO_2-PROJECT). Pfost, H.; Seitz, K. (Siemens A.G., Erlangen (West Germany); Lauer, M. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)). Oct 1970. 80p. (In German). Dep. NTIS (U. S. Sales Only).

It was investigated whether a CO_2 gas turbine cycle (Na/CO_2-project) could be an economic proposition for fast-breeder power stations as compared to a $Na/Na/H_2O$-plant. The following are described and determined: thermodynamic properties of the HP–CO_2-process at design parameters; variations of load and ambient temperature; cost differences with respect to SNR; and economy at 1000 MW(e). It is concluded that the Na/CO_2-concept can be realized, but the lower efficiency cannot be compensated by plant costs. At partial load the efficiency decreases quickly. (auth)

8080 (DP-Report-429) FISSION PRODUCT DETERMINATION ON THE 10 MW RUN FOR THE DRAGON REACTOR. Project DRAGON. Gray, P. S.; Reed, D. L.; Bartlett, A. C. (Atomic Energy Establishment, Winfrith (England)). May 1966. 28p. (CONF-660318-9). Dep. NTIS.

From Dragon Contractors' Research and Development Symposium, Harwell, England.

Measurements have been made of the activity of the purge from each fuel element and of the main coolant of the Dragon Reactor during the 10 MW run. These measurements are reported and only tentative conclusions are drawn from them since the methods of making the measurements are still under development. 5 references. (auth)

8081 (NSJ-tr-162) ANALYSIS AND EVALUATION OF THE D_2O MODERATED POWER REACTORS. Mochizuki, Hiroji. Translated from FAPIG (Tokyo); No. 50, 90-101(Aug 1968). 33p. Dep. NTIS (U. S. Sales Only).

Analysis and evaluation were made on two D_2O moderated power reactors: a CO_2-cooled reactor and a boiling light-water reactor. For the boiling water reactor, the feasibility of using natural U, and the nuclear heating characteristics of the Pu and natural fuel were studied. It was shown that natural U could be used in this type of reactor, that the positive void coefficient could be suitably suppressed, and so on. For the CO_2-gas cooled reactor, the heterogeneity effect in fuel arrangement in the channels, the dynamic characteristics, and the nuclear safety were extensively studied, extending the range of CO_2 gas pressure. Also, the burnup characteristic and the refuelling characteristic, starting from natural U to the fuel of natural U and Pu, were pursued. It was confirmed that the D_2O moderated, CO_2-gas cooled reactor has superior performance as an advanced converter, with few restrictions in design and operation. (8 references) (auth)

8082 NUCLEAR FUEL CYCLE MANAGEMENT. Noc, Bernard (Electricite de France, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 43-9(Jul-Aug 1970). (In French). (CONF-700903-3).

From 4th Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden.

The different technical and economic factors which govern the rational administration of nuclear fuels are reported, the management of the in-pile cycle and that of the out-pile cycle being examined separately. The special obligations of the electricity producer are studied and the in-pile fuel management chart is established: fuel turnover, economic study, ordering of fuel, reprocessing service and short term operational directives. Short term out-pile management is separated from the long term administration of fuels. The out-pile management chart includes the functions which govern the transfer of materials through the fuel manufacturing and reprocessing plants. (France)

Safety and Siting

Refer also to abstracts 6661 and 6701.

8083 (AAEC/TM-558) FINITE DIFFERENCE METHOD FOR TRANSIENT TWO-PHASE COMPRESSIBLE FLOW. Turner, W. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug 1970. 14p. Dep. NTIS (U. S. Sales Only).

In CANDU reactors the depressurization phenomena can be divided into two parts. First, the pressure in the liquid part of the coolant circuit drops over a few milliseconds to the saturation pressure of the coolant. In the second part where the system pressure decreases to atmospheric over at least 10 seconds, sonic effects are not of interest, but the dependence of the coolant density on pressure must be included. Time steps of the order of the time for a sonic wave to pass through one space step have been necessary in the analysis, but a finite difference method has now been developed which allows much larger time steps. All the derivatives and the frictional pressure drop in the conservation equations are forward-averaged in time. The implicit equations obtained together with the boundary conditions are then solved by a non-iterative method to obtain the enthalpy, flow and pressure at all space points at the end of the time step. The computation required per time step is proportional to the number of space points. (auth) (Australia)

8084 (AI-AEC-12979) LMFBR SAFETY PROGRAMS. Quarterly Technical Progress Report, July–September 1970. (Atomics International, Canoga Park, Calif.). 12 Nov 1970. Contract AT-(04-3)-701. 39p. Dep. NTIS.

LIQUID METAL FAST BREEDER REACTOR—safety programs during July to September 1970
—coolant combustion accidents in, release and transport of aerosols and energy from sodium, (E/T)
—kinetics of, effects of sodium coolant boiling on, (E/T)
SODIUM—combustion in liquid metal cooled reactor accidents, release and transport of aerosols and energy from, (E/T)
—boiling in liquid metal cooled reactors, initiation and thermal hydraulics aspects of, (E/T) (H.D.R.)

8085 (BNWL-SA-3093(Vol.1)) LECTURE SERIES, FAST REACTOR SAFETY TECHNOLOGY AND PRACTICES. VOLUME I. SAFETY PRACTICES AND BACKGROUND INFORMATION. Hofmann, P. L. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1970. Contract AT(45-1)-1830. 245p. Dep. NTIS.

Included are 9 papers on general background information and safety practices for sodium cooled fast reactors. A separate abstract was prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 8055, 8062, and 8086–8092.

8086 (BNWL-SA-3093(Vol.1), pp I.1-22) SAFETY AND REGULATORY REQUIREMENTS AND PRACTICES. Simpson, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume I. Safety practices and background information.

The question of reactor safety in relationship to the regulatory requirements and procedures of the AEC is discussed. Important administrative requirements and procedures which must be observed and technical assessments which must be made are examined. Plans and practices for the safety assessment of the FFTF are presented. (9 references) (H.D.R.)

8087 (BNWL-SA-3093(Vol.1), pp II.1-26) KEY PROBLEMS IN FAST REACTOR SAFETY. Simpson, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume I. Safety practices and background information.

Key technical problems in fast reactor safety analysis which may be subject to extensive discussion in the regulatory process are reviewed. Safety analysis procedures, accidents considered in process system design, and protection against accident consequences are discussed. (H.D.R.)

8088 (BNWL-SA-3093(Vol.1), pp III.1-27) CLASSIFICATION OF FAST REACTOR ACCIDENTS AND ACCIDENT SEVERITY LEVELS. Stepnewski, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume I. Safety practices and background information.

The purposes behind classification of fast reactor accidents and devising accident severity criteria to various protection levels are discussed. The criteria adopted for FFTF accident severity levels are presented. (5 references) (H.D.R.)

8089 (BNWL-SA-3093(Vol.1), pp IV.1-29) BIOLOGICAL EFFECTS OF RADIATION. Bunch, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume I. Safety practices and background information.

The causes and effects of biological damage by radiation, definitions of dosage terms, and regulatory agencies and standards

are discussed. The effects of radiological factors on reactor facility design are examined. (10 references) (H.D.R.)

8090 (BNWL-SA-3093(Vol.1), pp VI.1-32) REACTOR SITING PROBLEMS. Hale, J. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume I. Safety practices and background information.

The legal, economic, geological, and safety considerations involved in siting a reactor are reviewed. Radiation standards and instructions are discussed, and methods for radiation exposure calculations are examined. (H.D.R.)

8091 (BNWL-SA-3093(Vol.1), pp VII.1-15) FUNDAMENTALS OF FAST REACTOR KINETICS. Little, W. W. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume I. Safety practices and background information.

The neutronics models used in fast reactor kinetics analyses are briefly described. Included are discussions of the time dependent diffusion equation, the lumped parameter approximation, period-reactivity relationships, and the first-order perturbation equation. (H.D.R.)

8092 (BNWL-SA-3093(Vol.1), pp IX.1-38) SODIUM FLUID DYNAMICS. Padilla, A. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume I. Safety practices and background information.

The three mechanisms for the expulsion of sodium from reactor cooling channels are examined. The mechanisms are sodium boiling, expansion and release of fill and fission gases following clad rupture, and a molten fuel-sodium interaction. The pressures generated during expulsion and reentry are discussed. (34 references) (H.D.R.)

8093 (BNWL-SA-3093(Vol.2)) LECTURE SERIES, FAST REACTOR SAFETY TECHNOLOGY AND PRACTICES. VOLUME II. ACCIDENT ANALYSIS. Hofmann, P. L. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1970. Contract AT(45-1)-1830. 597p. Dep. NTIS.

Included are 11 papers on the description and sequence of major fast reactor accidents and fast reactor accident analysis techniques. A separate abstract was prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 8077, 8078, and 8094–8102.

8094 (BNWL-SA-3093(Vol.2), pp X.1-37) FUEL FAILURE MECHANICS AND FAILURE PROPAGATION. Hanson, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

Aspects of fuel pin performance which relate to the safety characteristics of the Fast Test Reactor are discussed. Postulated fuel failure mechanisms and thresholds are defined and related to the design safety criteria of the FTR. (H.D.R.)

8095 (BNWL-SA-3093(Vol.2), pp XI.1-33) REACTIVITY ACCIDENTS. Stepnewski, D. D.; Fies, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

Potential reactivity perturbations which constitute an off-normal operating condition and which may require plant protective action to correct are discussed. Computational methods used in reactivity accident analysis are presented and applied to some typical reactivity accidents included in safety analysis reports. (7 references) (H.D.R.)

8096 (BNWL-SA-3093(Vol.2), pp XII.1-126) ANALYSIS OF LOSS OF COOLING ACCIDENTS. Johnson, H. G. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

Simulation methods used for the analysis of cooling system components are described. Failures of active components such as pumps, fans, and process controls and of passive components such as pipes are included. Situations involving single failures and situations involving sequential faults are examined. (H.D.R.)

8097 (BNWL-SA-3093(Vol.2), pp XV.1-68) MATHEMATICAL MODELS OF REACTOR POWER EXCURSIONS. Waltar, A. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

Procedures for analyzing the course of a sodium cooled fast reactor transient from accident inception to logical termination are discussed. The discussion centers on the use of the MELT-II code for analysis of severe accidents up to the point of core disassembly. (11 references) (H.D.R.)

8098 (BNWL-SA-3093(Vol.2), pp XVI.1-62) MATHEMATICAL MODELS OF REACTOR DISASSEMBLY. Waltar, A. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

Techniques for the analysis of fast reactor accidents involving core meltdown and compaction into a more reactive configuration are discussed. The historical evolution of the analytical methods is examined, and techniques in current use are described. (24 references) (H.D.R.)

8099 (BNWL-SA-3093(Vol.2), pp XVII.1-49) ENERGY RELEASE MECHANISMS. Padilla, A. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

Methods for predicting the shock and blast energies resulting from a fast reactor disruptive accident are described. The various assumptions necessary for the calculations are discussed, and energy release from various sources in the core disassembly is examined. (18 references) (H.D.R.)

8100 (BNWL-SA-3093(Vol.2), pp XVIII.1-41) EFFECTS OF REACTOR ACCIDENTS ON REACTOR VESSEL AND HEAD. Fox, G. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

The effects of the energy released within the reactor vessel during a core disassembly accident are examined. Techniques used to analyze design basis accident characteristics are described. Shock and blast wave effects are discussed, and the results of some reference reactor case calculations are presented. (8 references) (H.D.R.)

8101 (BNWL-SA-3093(Vol.2), pp XIX.1-43) SODIUM FIRES. Shire, P. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

The effects of energy contributions from sodium fires on containment vessel design requirements are examined. The various factors involved in and energy releases from sodium pool fires, spray fires, and sodium-water reactions are discussed. Some typical theoretical and experimental data are presented. (17 references) (H.D.R.)

8102 (BNWL-SA-3093(Vol.2), pp XX.1-66) SURVEY OF FAST REACTOR SAFETY R AND D PROGRAMS. Hagan, J. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Lecture series, fast reactor safety technology and practices. Volume II. Accident analysis.

Development programs related to fast reactor safety are identified and their specific objectives, facilities, and status are summarized. Safety technology in these programs which is applicable to the design and evaluation of the FFTF is identified. (H.D.R.)

8103 (DOCKET-50231-60) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. License No. DR-15; Technical Specifications Proposed Change No. 4, Rev. 1. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 11 Dec 1970. 44p. Dep. NTIS.

Revised and additional information concerning reactor kinetics and stability is presented. (D.C.C.)

8104 (IA-1206) QJHAZ: A PROGRAM FOR THE EVALUATION OF ENVIRONMENTAL HAZARDS FROM NUCLEAR REACTORS. Milman, Y.; Tadmor, J. (Israel Atomic Energy Commission, Tel Aviv). Jun 1970. 28p. Dep. NTIS (U. S. Sales Only).

A program for numerical calculation of environmental hazards resulting from an accident in a nuclear reactor is described. Nuclear, meteorological and radiological subroutines are presented in detail, and a glossary of symbols, program write-up and a sample calculation are given. The program is written in ALTAC language for the PHILCO 2000/212 computer. (7 references) (auth)

8105 (IDO-ES-616) AMBIENT VIBRATION SURVEY AND MATHEMATICAL ANALYSIS OF THE CAROLINAS-VIRGINIA TUBE REACTOR. (Earth Sciences, Pasadena, Calif.). Sep 1968. Contract C-638 T.A. No. 1. 88p. Dep. NTIS.

For Phillips Petroleum Co., Idaho Falls, Idaho.

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The ambient vibration survey method of determining the dynamical characteristics of a reactor and its containment structure is shown to be both feasible and practical. The large amount of piping and equipment resulted in an unusually large number of peaks in the power spectra plots, which made the interpretation of the power spectra more time consuming than had been anticipated. The resonant modes of vibration were strongly influenced by a pipe which eccentrically connected the inner structure to the containment vessel. The lack of symmetry of the structure necessitated two mathematical models. In one of these, torsional effects were considered. The study shows that for good results, one three-dimensional mathematical model should be constructed. An important aspect of the mathematical models was the soil springs. The soil springs as calculated mathematically gave a fundamental frequency of vibration considerably higher than shown by the field data. Damping coefficients obtained from the experimental work were lower than values used in normal analysis. The brief experiment devoted to determining the feasibility of studying soil-structure interaction by the ambient vibration survey method produced encouraging results. In analyzing the experimental data it was noted that there was an exchange of energy between buildings. 11 references. (auth)

8106 (IN-1404) SEMISCALE BLOWDOWN AND EMERGENCY CORE COOLING (ECC) PROJECT TEST REPORT: TESTS 803 THROUGH 820. Heiselmann, H. W.; Olson, D. J.; Whitbeck, J. F. (Idaho Nuclear Corp., Idaho Falls). Oct 1970. Contract AT(10-1)-1230. 183p. Dep. NTIS.

A portion of the results of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project tests conducted at the National Reactor Testing Station as part of the Water Reactor Safety Program of the Atomic Energy Commission is reported. The purpose of the Semiscale Blowdown and Emergency Core Cooling Project is to provide the experimental data base required for development and assessment of analytical models for predicting the thermal hydraulic behavior occurring in a large PWR during a loss-of-coolant accident (LOCA). The results reported were obtained from decompression experiments on a circulating loop connected to a simulated reactor vessel (without internals) that constitute an extension of previous decompression tests with only a vessel. All tests were initiated from isothermal fluid conditions. Reported are pressure, temperature, strain, momentum, flux, thrust, and limited flow and density information for various break sizes, configurations, and initial conditions. The amount of water remaining, blowdown time, and indications of the thermodynamic processes are also reported. (auth)

8107 (NSJ-tr-161) ASEISMIC DESIGN OF NUCLEAR POWER PLANTS: DEVELOPMENTS OF THESE TEN YEARS. Shibata, Heki. Translated from Seisan Kenkyu; 20: 6-16(Aug 1968). 27p. Dep. NTIS (U. S. Sales Only).

Various aspects and problems in the aseismic design of nuclear power plants are described chronologically for the past ten years. The present state of aseismic design of nuclear power plants including the course of studies on design of structures, equipment, vessels, and piping, is summarized. (auth)

8108 (TID-25580) SOIL BEHAVIOR UNDER EARTHQUAKE LOADING CONDITIONS. REVISED PROGRAM DEFINITION. (Shannon and Wilson, Inc., Seattle, Wash. Agbabian-Jacobsen Associates, Los Angeles, Calif.). [1970]. Subcontract 3354. 28p. Dep. NTIS.

The technical approach and schedule for a study of methods to predict the behavior of soils at nuclear power plant sites under earthquake loading conditions are presented. The project schedule includes tasks to be undertaken over 3½ years. (H.D.R.)

8109 EQUATION OF STATE FOR FAST REACTOR SAFETY STUDIES. PART I. THEORETICAL RELATIONS. Miller, David (Argonne National Lab., Ill.). Nucl. Safety; 11: 450-63(Nov-Dec 1970).

The equation of state is important in fast reactor safety studies because it couples the rate of energy deposition with the deformations and damage that can be produced in an accident. The application of the equation of state to reactor problems is discussed. Important properties and processes, along with limitations on their applicability are indicated. The equation of state is a complex entity, with both thermal and mechanical dependencies. Because of the wide range of conditions that might be important in accident analyses, consideration must be given to a wide variation of properties. Materials of principal interest are the fuel and fertile materials (metallic or ceramic), cladding and structural materials (generally iron alloys), and the sodium coolant; each has special characteristics. Although experimental data are available for many of these materials, theory and empiricism must be used to extend and apply the data. 74 references. (auth)

8110 SOME SAFETY ASPECTS OF FAST REACTORS. Schoelvinck, R. G. (Reactor Centrum Nederland, Petten). Atoomenergie Haar Toepass.; 12: 273-84(Oct 1970). (In Dutch).

Some potential fast reactor accidents, which might have serious consequences for the public, the operating personnel, and the reactor proper are discussed. Emphasis is placed on the continued balance between power generation and heat removal throughout the reactor core, in order to maintain fuel integrity. Possible reactivity additions are discussed, together with quality standards for the primary coolant circuit. Reliability estimates seem to require two independent systems for reactor shut down and for decay heat removal. Most of the discussion deals with sodium cooled fast reactors. Some comments are offered on safety aspects of gas cooled and steam cooled fast reactors. (auth) (Netherlands)

8111 RELIABILITY ANALYSIS OF COMPLEX SYSTEMS WITH THE AID OF THE FAULT-TREE METHOD. Mieze, G. (Technische Ueberwachungs-Vereine , Cologne). Kerntechnik; 12: 377-87(Sep 1970). (In German and English).

A method is described for determining the probability of occurrence of an undesired event in a complex system. A simple example is used to illustrate the nine steps required for such an analysis, including system definition, conversion into a reliability model, computation of the model, and assessment of the results by comparison to a standard. The limits and the accuracy of the model and of the input data are discussed. (5 references) (auth)

Power Conversion Systems

8112 POSSIBILITIES OF USING GAS-TURBINE UNITS AND MAGNETOHYDRODYNAMIC GENERATORS IN ATOMIC POWER PLANTS WITH HIGH-TEMPERATURE GAS-COOLED REACTORS. Millionshchikov, M. D.; Lyul'ka, A. M.; Nedospasov, A. V.; Sheindlin, A. E. High Temp. (USSR) (Engl. Transl.); 8: 351-63 (Mar-Apr 1970).

Translated from Teplofiz. Vys. Temp.; 8: 379-93(Mar-Apr 1970).

A study was made of the possible combinations of HTR's with gas-turbine units and MHD generators as power blocks of 1200 MW. The thermal circuits and equipment arrangements of such power plants are analyzed, and economic indices are calculated on the 1980-85 price level. The results show that costs are less than for conventional fossil plants, and that a MHD generator at 1700°C gives the same economic indices as a gas-turbine unit at 850°C. (D.L.C.)

8113 PRINCIPAL DESIGNS OF STEAM GENERATORS FOR INDIRECT-CYCLE NUCLEAR POWER PLANTS. Kaegi, J. Sulzer Tech. Rev.; 52: No. 1, 22-9(1970).

Steam generating plants are classified as helix, meander, straightflow, or U-tube generators according to the arrangement of their heating surfaces. The various types are defined and their employment in nuclear power plants is illustrated by examples. Specific steam raising data for the various types of reactors are compared. (auth)

Research and Test Reactors

Refer also to abstracts 6847, 8047, 8075, 8088, and 8094.

8114 (ANL-7215) EXPERIMENTS WITH A SERIES OF SMALL, Pu-PLUS-U-FUELED FAST-REACTOR CRITICALS (FARET MOCKUP-ZPR-3 ASSEMBLY 46). Hess, Allen L.; Keeney, William P.; McVean, Robert L. (Argonne National Lab., Ill.). Jan 1970. Contract W-31-109-eng-38. 97p. Dep. NTIS.

ZPR-3 Assembly 46 was a series of small Pu-plus-U-fueled fast-reactor cores studied in conjunction with design efforts for FARET, a conceptual fast-fuels test reactor. Six different cores, labeled A through F, were constructed as mockups of possible FARET loadings. Cores A and B simulated PuC-UC-fueled cores with volumes of 57 and 68 liters, respectively. Core C was an 87-liter system with a PuO_2-UO_2 fuel representation. Cores D, E, and F, with volumes of 80, 108, and 95 liters, respectively, were each composed of four annular fuel zones. The different zones contained simulations of oxide, carbide, and alloy fuels as mockups of envisaged multifueled FARET cores. An additional three-zoned core, Core G, was used for fast-reactor physics experiments of a general nature. Principal experiments with the mockups were: evaluating the reactivity control afforded by FARET-design B_4C control rods, measuring worths of fuel interchanges, obtaining flux distributions, and measuring reactivity coefficients for core-constituent materials. 16 references. (auth)

8115 (EURFNR-826) ACTIVITY REPORT OF 1968. PART II. STUDIES AND DEVELOPMENT OF A 140 MWth SODIUM-

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COOLED FAST REACTOR FOR FUEL ELEMENT TESTING. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). 188p. (In Italian). Dep. NTIS (U. S. Sales Only).

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The CNEN activities on the design and development of the PEC reactor are summarized. Separate sections discuss the design and construction programs, design activities on specific plant components and systems, and civil engineering aspects of the conventional structures and equipment. (H.D.R.)

8116 (GA–9027) FAST REACTOR SPECTRUM MEASUREMENTS. Quarterly Progress Report for the Period Ending July 31, 1968. Preskitt, C. A.; Neill, J. M.; Young, J. C. (Gulf General Atomic, Inc., San Diego, Calif.). 7 Oct 1968. Contract AT-(04-3)-167. 26p. Dep. NTIS.

The effort was primarily devoted to operations on a high-intensity experiment designed to produce integral data on alpha for ^{239}Pu (STSF-1A). In addition, further analysis was performed on the data obtained with STSF-1, and some planning and initial operations were performed for future loadings, STSF-3 and STSF-4. To obtain the desired intensity in STSF-1A a new high-power air-cooled target was designed and installed. This system uses uranium metal as source material and has a design capability of 8 kW dissipation. It has been operated for extended test periods at powers up to 5 kW. Spectral measurements and several plutonium and uranium foil irradiations were performed in STSF-1A. (auth)

8117 (NP–18562) MESPR066: THE OPERATION SYSTEM OF THE INTEGRATED DOUBLE COMPUTER INSTALLATION MIDAS OF FR2. PROGRAM DESCRIPTION. Wuerz, Gisela (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Nov 1969. 33p. (In German). Dep. NTIS (U. S. Sales Only).

The double computer system MIDAS installed at the nuclear research reactor FR2 in Karlsruhe controls the acquisition, processing and storing of the measuring data of 8 independent nuclear experiments in realtime. The experimenter controls the experimental process by command panels and display units. The processed data and in some cases the raw data are recorded onto magnetic tape. All experiments connected to MIDAS are measuring several parameters in many channels. Therefore a special analyzing program using disk memory has been developed which performs the on line acquisition of 256K channels. Hardware and software of MIDAS have been extended by steps. The system has been in continuous operation since 1963. The operating system MESPRØ66 which has been designed for the double computer system is described. (8 references) (auth)

8118 (ORNL–TM–3235) BULK SHIELDING FACILITY QUARTERLY REPORT, JULY–SEPTEMBER 1970. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). 12 Nov 1970. 25p. Dep. NTIS.

The BSR operated 77.7% of the time at an average power level of 1,966 kW during July, August, and September of 1970. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. There were six unscheduled shutdowns, four of which were caused by shim rods dropping, one by failure of the safety trouble monitor, and one by an experiment malfunction. Of the four unscheduled shutdowns caused by dropping of shim rods, one was caused by the No. 1 shim rod and three by the No. 3 shim rod. Changes were made in the shim-rod-drive units, as authorized by reactor controls change memorandum No. BSR-2Mw-24. These changes included the installation of a newly designed lower guide tube, shock cup, seat switch, shim-rod extension, and improved components of the shock absorber. The PCA was not used during the three month period and remained in a secured condition. (auth)

8119 (RT/FI–(70)16) USE OF DIGITAL ON–LINE COMPUTER FOR NUCLEAR REACTOR PHYSICS EXPERIMENTS. Ferrari, T.; Martinelli, R.; Pacilio, N.; Valent, V. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 25 Mar 1970. 72p. (In Italian). Dep. NTIS (U. S. Sales Only).

A small digital computer (PDP-8, 12-bit word, 4K-word memory) is being used for on-line data collection and reduction, analysis, and control of some critical facilities at C.S.N. Casaccia, in five reactor-physics procedures. They concern: (1) relative measurements of absorption cross-sections via oscillating samples; (2) statistical analysis of nuclear particle detection processes; (3) reactor-noise time-analysis methods for prompt-neutron lifetime and reactivity measurements in reactor systems: (4) pulsed-neutron experiments; and (5) reactor stable-period experimental determination. (auth)

8120 (WHAN–FR–12) ANALYSIS OF ZPPR/FTR SHIELD EXPERIMENTS: NEUTRON DISTRIBUTION. Boulette, E. T. (WADCO Corp., Richland, Wash.). Oct 1970. Contract AT-(45-1)-2170. 121p. Dep. NTIS.

Two-dimensional diffusion theory calculations are shown to predict realistically the measured neutron-induced reaction rates [^{238}U(n,f) ^{239}Pu(n,f), ^{10}B(n,α), ^{23}Na(n,γ), ^{55}Mn(n,γ)] throughout the core, reflector, and radial shield of test assembly FTR-2, which was loaded in the Zero Power Plutonium Reactor facility. In the areas where disagreement between the calculations and measurements was noted, the measurements provide a basis for any required empirical adjustments in design calculations to assure that the Fast Test Reactor radial shield will perform satisfactorily. 13 references. (auth)

8121 (Y–DR–29) FEASIBILITY STUDY OF AN AUTORADIOGRAPHIC TECHNIQUE FOR THE DETERMINATION OF RELATIVE POWER DENSITIES IN REACTOR FUEL PLATES. Magnuson, D. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 20 Nov 1970. Contract W-7405-eng-26. 33p. Dep. NTIS.

Auto-radiography has been shown to be a feasible method for determining fission density distributions in the fuel plates of reactors. Because the U was not uniformly distributed between the cladding of the fuel plates, the film response varied for auto-radiographs made from opposite sides of an irradiated fuel plate. However, it was found that the average film response was independent of the U distribution and a single calibration was found to be adequate for U loadings which varied from 6.9 to 17.3 mg of ^{235}U per cm^2. (auth)

8122 EFFECT OF ^{241}Pu DECAY ON THE ANALYSIS OF PLUTONIUM CRITICAL EXPERIMENTS. Uotinen, V. O. (Battelle–Northwest, Richland, Wash.). Contract AT(45-1)-1830. Nucl. Sci. Eng.; 42: 107–9(Oct 1970).

Since ^{241}Pu beta-decays with a half-life of 14.5 years, the depletion of this isotope must be considered in interpreting critical experiments. As an illustration, this effect is calculated for several light-water-moderated lattices of UO_2–4 wt.% PuO_2 fuel rods. Dates of isotopic analyses, ^{241}Am content, and dates of critical experiments should all be reported in journal articles. More precise data on ^{241}Pu and ^{241}Am would also help reduce experimental uncertainties. (R.W.R.)

8123 APPARATUS FOR DILATATION OF MICROSPECIMENS IN LOW TEMPERATURE CHANNELS OF REACTORS. Naskidashvili, I. A.; Lapiashvili, E. S.; Lezhava, A. N.; Katsitadze, Dzh. G. At. Energ. (USSR); 28: 55–8(Jan 1970). (In Russian).

A small installation was designed for expansion tests of microspecimens in a cold reactor channel with an automatic recording of expansion curve by a two-coordinate DRP-type instrument. The installation with a smooth loading and unloading process enabled testing of specimens 1 to 2.5 mm in diameter during irradiation in a wide range of temperatures from liquid N_2 to 370°K. Tests made with technical grade irradiated with 3.6×10^{17} n/cm^2 at 150° showed an increase of specimen strength of 12% (from 11.0 to 12.3 kg/mm^2) and yield 16.5% (from 5.4 to 6.3 kg/mm^2). The elongation remained unchanged. (R.V.J.)

8124 LEAKAGE GAMMA-RAY SPECTRA AROUND KUR DURING PERIOD OF POWER INCREASE. Nakashima, Yoshiyuki (Nagoya Univ., Japan); Minato, Susumu; Kawano, Minoru; Tsujimoto, Tadashi; Katsurayama, Kousuke. Nippon Genshiryoku Gakkaishi; 12: 577–81(1970). (In Japanese).

Leakage γ-ray spectra were studied with c NaI(Tl) scintillation counter during a period of power raising to 5 MW. The tests lasted from April to July 1968. The pulse height distributions observed with the counter were unfolded by using an inverse 46 × 46 matrix. Despite spatial dependence of the leakage γ-ray spectra, the spectrum of each position was found to remain unaltered by the change in reactor output. The spectra were observed to cover a wide range up to 9 MeV, and the γ-rays from ^{41}Ar and ^{16}N present in the atmosphere were observed as peaks superimposed on the continuous spectrum of the leakage γ-rays. When the reactor was shut down, the spectra were limited to a range below 3 MeV. Exposure rates calculated from the corrected spectra agreed fairly well with those measured with an ionization chamber. 7 references. (auth)

Rocket and Space Reactors

8125 (SWRHL–72–r) FINAL REPORT OF ENVIRONMENTAL SURVEILLANCE FOR PHOEBUS 2A REACTOR TEST SERIES, MAY–JULY 1968. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Oct 1970. 54p. Dep. NTIS.

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During the months of May through July 1968, the Phoebus 2A nuclear reactor (5000 MW design-power) was tested through five Experimental Plans (EP's) at Test Cell C, Nuclear Rocket Development Station. For these tests the Southwestern Radiological Health Laboratory conducted radiological monitoring and environmental sampling in off-site areas surrounding the Test Range Complex. During EP III, IV, and V, the reactor was operated at power levels near 2000, 4000, and 4000 MW, respectively, releasing airborne radioactivity which was detected in off-site areas. The EP III effluent traveled southeast from Test Cell C, being detected between Mercury and Las Vegas, Nevada. The effluent from EP IV traveled to the northeast as far as Monticello, Utah, with other portions being detected at Bishop, California, and Lathrop Wells, Nevada. The EP V effluent traveled to the northeast and was detected as far as Wendover, Utah. As a result of these tests, some radioactive contamination occurred off-site which was detected in air and vegetation samples collected following the three tests and additionally in milk and cow feed samples collected for EP IV and V. Only the EP III and EP V effluents were detectable with GM survey instruments. The maximum external radiation exposure measured off-site following EP V was less than 0.1 mR at Queen City Summit, an unpopulated area. The maximum postulated absorbed dose to the thyroid of a child with a 2-g thyroid was 13 mRad at Blue Eagle Ranch following EP V. These doses were below the radiation protection standards of AEC Manual, Chapter 0524. 13 references. (auth)

Marine and Portable Power Reactors

8126 (DOCKET-50238-75) N. S. SAVANNAH. Abnormal Occurrence Report: Rupture of Air Operator Diaphragm of Pressurizer Spray Isolation Valve. (First Atomic Ship Transport, Inc., New York). 30 Nov 1970. 2p. Dep. NTIS.

8127 (DOCKET-50238-76) N. S. SAVANNAH. Operations Report, April 26–November 9, 1970. (First Atomic Ship Transport, Inc., New York). Dec 1970. 14p. (FAST-21). Dep. NTIS.

8128 SOME OPERATIONAL EXPERIENCES WITH THE NUCLEAR-POWERED BULK CARRIER OTTO HAHN. Ulkin, D. Motor Ship; 51: 387-8(Nov 1970).

A brief description is given of the reactor and its installation. The nuclear plant is an advanced pressurized water reactor with integrated construction and self-pressurization. Interesting features of the reactor observed during extensive research trips include its maneuverability, stability under severe load changes, and neutron flux movements under ship motions. The success of the trial voyages should lead to an economic marine reactor of this type for higher powered ships. (UK)

Reactor Theory

Kinetics

Refer also to abstracts 8057, 8091, and 8109.

8129 (AEEW-M-952) MODIFICATIONS TO PERSEUS REQUIRED TO SOLVE HYDROGENOUS SYSTEMS. Clayton, A. J. (Atomic Energy Establishment, Winfrith (England)). Oct 1970. 9p. Dep. NTIS (U. S. Sales Only).

The main transport option in WIMS includes the collision probability method PERSEUS which incorporates PIP1 to solve the equations. Attempts to use WIMS with systems containing large amounts of hydrogen have incurred convergence troubles which could only be overcome by experimenting with the acceleration parameter. Apart from such experimenting being undesirable from the user point of view the resulting convergence has always been slow. Similar troubles have arisen in the hyperfine calculation, which also used PIP1. The cause of the poor convergence is due to the presence of negative self-scatter cross-sections introduced by the diagonal transport correction, and is worst in the hyperfine calculation because of the narrow groups and consequent small true self-scatter. The measures adopted in PERSEUS and the spectrum calculation to improve the convergence rate are described. (auth) (UK)

8130 (CEA-N-1276) CESAR AND CONCORDE. APPLICATION OF THE CONCORDE HEXAGONAL SYNTHESIS PROGRAM TO EXPERIMENTS ON THE CESAR CRITICAL REACTOR. Nguyen-Ngoc, Hoan (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Charbonneau, Serge (Electricite de France, Paris). Oct 1970. 40p. (In French). Dep. NTIS (U. S. Sales Only).

Three-dimensional neutron diffusion equations can be solved by the method of synthesis whose essential advantages are the rapidity and the possibility of facing a great number of mesh points. This method was used for calculating the axial flux in a hexagonal reactor, the trial functions of two variables being furnished by the classical finite difference method. A comparison of the results given by such a calculation with measurements performed on the critical experimental facility Cesar implanted in the Cadarache Nuclear Research Center is presented. (8 references) (auth)

8131 (WAPD-TM-978) NEW STATIC FLUX SYNTHESIS MODEL FOR MOVABLE MATERIAL REACTOR PROBLEMS (LWBR DEVELOPMENT REPORT). Yasinsky, J. B.; Foulke, L. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov 1970. Contract AT(11-1)-Gen-14. 33p. Dep. NTIS.

A new approach to spatial synthesis is developed with emphasis on the dependence of the flux between axial solution points. The standard synthesis approach (as well as all spatial differencing methods used for neutron diffusion problems) assumes that the flux is a piecewise constant function of z. That is, the flux is constant over some axial region about each axial solution point. It is shown that the standard approach leads to nonphysical results for problems where material interfaces (such as control rod interfaces or movable zoned fuel region interfaces) are moved so that they fall between axial solution points. New synthesis methods, based on the use of continuous piecewise polynomials to represent the z dependence of the flux, are shown to result in improved solutions for such movable material problems. This new approach permits material interfaces to fall on or between mesh points. There is no requirement that material interfaces line up with solution points. (auth)

8132 HETEROGENEOUS METHOD FOR THERMAL FLUX FINE STRUCTURE CALCULATION IN LIQUID MODERATED NUCLEAR REACTORS. Jovanic, M. (Energoprojekt, Belgrade). J. Nucl. Energy; 24: 403-17(Nov 1970).

The heterogeneous source-sink method was used for the calculation of the thermal-flux fine structure of cluster type fuel elements in liquid-moderated reactors. It was assumed that diffusion (P – 1) theory is valid outside the fuel rods, and that the properties of coolant and moderator may be different. The fuel channel tube, which separates the coolant and moderator, absorbs thermal neutrons but is transparent to fast neutrons. The fuel rods are sources of fast neutrons and sinks of thermal neutrons. The thermal constant is used for boundary conditions. Two-group diffusion equations were solved under conditions such that both fast and thermal neutron current vanish at the cell boundary. The calculations were performed for 19-rod natural uranium metal assemblies and the results were compared with Chalk River experiments. (auth) (UK)

Dynamics

8133 (COO-2109-2) STABILITY OF NUCLEAR REACTOR SYSTEMS HAVING TIME DELAYS. Kearns, Kenneth Dermot (Arizona Univ., Tucson. Dept. of Nuclear Engineering). Jun 1971. Contract AT(04-3)-670. 117p. Dep. NTIS. Thesis.

A technique based on the Mikhailov stability criterion has been developed to study the effects of time delays on the stability of linear systems. Specifically, the technique utilizes Descartes' rule of signs and Sturm's theorem to determine regions within the system parameter space in which stability or instability is conditional on the value of the time delay. In these regions, the critical time delay indicating the stability boundary may also be determined. The method is applied to a seventh-order, in-core thermionic reactor model containing two coolant time delays between the radiator and the core. Stability is found to depend on the sum of the two delays. The results of the analysis reveal the existence of conditional instabilities within physically possible operating regions of the parameter space. Within the conditionally stable regions, several critical time delays are calculated to indicate how stability depends on the value of the time delay. A number of methods commonly used to study the stability of delayed systems are compared for their accuracy and ease of application. In addition, the results of the exact linear treatment are compared with three commonly applied approximations, all of which attempt to simplify the stability analysis. It is found that none of these approximations necessarily give conservative predictions of the exact stability zones. (auth)

Experimental Applications

8134 (BAW-3647-18) PHYSICS VERIFICATION PROGRAM. PART III, TASK 4. Quarterly Technical Report, April–June 1970.

Baldwin, M. N.; Stern, M. E. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Sep 1970. Contract AT(30-1)-3647. 12p. Dep. NTIS.

CRITICAL ASSEMBLIES—power profile measurements in water moderated, effects of lattice heterogeneities on
RADIATION DETECTORS—sensitivity of all-solid in-core, for neutron flux measurements, (E)
REACTOR CONTROL ELEMENTS—reactivity worth measurements on absorber samples (H.D.R.)

8135 (BAW-3647-19) PHYSICS VERIFICATION PROGRAM, PART III, TASK 4. Quarterly Technical Report, July–September 1970. Baldwin, M. N. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Dec 1970. Contract AT-(30-1)-3647. 16p. Dep. NTIS.

Unclad Pyrex glass rods, aluminum-clad Vicor glass rods, aluminum-clad Al_2O_3 rods, and water holes were spaced on selected patterns in an otherwise uniform clean lattice in the CX-10 facility. Their effects on the core midplane power shape are presented. (7 references) (H.D.R.)

8136 COMPARATIVE STUDIES OF THERMAL FLUX DEPRESSION MEASUREMENTS. Fasso, A. (CNEN, Bologna). Minerva Fisiconucl.; 13: 313-20(Oct-Dec 1969). (In Italian).

A large number of experimental works on flux depression caused by a foil detector is considered and the experimental data reprocessed and normalized. If a standard procedure is adopted for each set of data, a better agreement is found. For many purposes, it is possible to formulate in a simple way the depression factor dependence on physical and geometrical parameters. The empirical formula is compared with some theoretical predictions. (29 references) (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 6457, 6465, 6485, 6492, 6497, 6499, 6503, 6504, 6506, 6508, 6827, 6856, 6887–6890, 6892, 6907, and 8047.

8137 (KFK-1181) STOICHIOMETRIC SHIFT IN AN OXIDE FUEL ELEMENT AT HIGH BURNUP. Holleck, H.; Kleykamp, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Aug 1970. 74p. (In German). Dep. NTIS (U. S. Sales Only).

The contributing factors leading to a change in stoichiometry of an oxide-fuel during burnup are discussed. The arising fission products altered the average final stoichiometry, while gas equilibria above the oxide determines the stoichiometry at a particular point. Experimental results concerning irradiated samples are discussed and related to equilibrium states in fuels with high burnup. (62 references) (auth)

8138 (NP-18556) SEGREGATION OF URANIUM AND PLUTONIUM IN OXIDE FUEL UNDER THE INFLUENCE OF A TEMPERATURE GRADIENT. Schumacher, Gustav (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jul 1970. 102p. (In German). (INR-4/70-27). Dep. NTIS (U. S. Sales Only).

An apparatus was constructed for investigations of separation processes in mixed (U,Pu) oxide fuel materials subjected to a temperature gradient. The cylindrical specimens in sealed tungsten containers where exposed to temperatures up to 2800°K and longitudinal gradients up to 2000°K/cm. The measurement of the concentration by alpha-counting showed a decrease of plutonium in the columnar grain region and an accumulation at the hot end of the specimens. This separation is due to three processes, each of which causes a characteristical distribution of the plutonium concentration. The processes are: (1) preferential evaporation at the surface of the specimens, (2) preferential evaporation and condensation in migrating voids and (3) thermal diffusion. For the thermal diffusion a heat of transfer of 35 kcal/mol is estimated and longtime effects are calculated. The results of this study allow a discussion of the separation effects in reactor fuel elements. 41 references. (auth)

8139 CONTROL ROD ACTUATING ARRANGEMENT. Dempsey, John D. (to Babcock and Wilcox Co.). U. S. Patent 3,533,912. 13 Oct 1970. Filed 30 Nov 1967.

A control rod associated with the core of a nuclear reactor is movably mounted in a passageway extending into the core so that it can be hydraulically moved out of the core under the influence of primary coolant flow through the passageway. The flow of primary coolant is controlled by a valve assembly mounted within the reactor. The valve assembly incorporates a valve which responds to different primary coolant pressures within the reactor, and also responds to a flow of primary coolant which can be introduced into the reactor from an external source for moving the control rod in the passageway. (auth)

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GENERAL

8140 (BDX-613-194) . BEAM LEAD SEMICONDUCTOR TESTING AND HANDLING. Smith, L. W. (Bendix Corp., Kansas City, Mo.). Sep 1970. Contract AT(29-1)-613. 11p. Dep. NTIS.

8141 (BNL-14519) ASSOCIATIVE CAPABILITIES FOR MASS STORAGE THROUGH ARRAY ORGANIZATION. Peskin, Arnold M. (Brookhaven National Lab., Upton, N. Y.). 16 Mar 1970. 16p. Dep. NTIS.

8142 (BNL-50244) RISE OF BUOYANT CLOUDS. Frizzola, J. A.; Singer, I. A.; Smith, M. E. (Brookhaven National Lab., Upton, N. Y.). May 1970. 19p. Dep. NTIS.

8143 (BNWL-B-26) HYBRID SOFTWARE SYSTEM LIBRARY AND MACROS. Gerhardstein, L. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 21 Oct 1970. Contract AT(45-1)-1830. 102p. Dep. NTIS.

8144 (CONF-700114-1) COMPARISON OF THE MOESSBAUER EFFECT TO TIME DIFFERENTIAL PERTURBED ANGULAR CORRELATIONS: THE CASE OF ^{57}Fe IN A Ni HOST. Hohenemser, C. (Brandeis Univ., Waltham, Mass. Dept. of Physics). [1970]. 16p. Dep. NTIS.
From 6th Moessbauer Symposium, Chicago, Ill.

8145 (CONF-700933-3) PERTURBED ANGULAR CORRELATION EXPERIMENTS ON ^{100}Rh IN A Ni HOST NEAR THE CURIE POINT. Reno, R. C.; Hohenemser, C. (Brandeis Univ., Waltham, Mass. Dept. of Physics). [1970]. 5p. Dep. NTIS.
From Conference on Hyperfine Interactions Detected by Nuclear Radiation, Rehovot and Jerusalem, Israel.

8146 (CONF-700933-4) HYPERFINE FIELD OF Sc IN A Ni HOST. Benski, H. C.; Hohenemser, C. (Brandeis Univ., Waltham, Mass. Dept. of Physics). [1970]. 5p. Dep. NTIS.
From Conference on Hyperfine Interactions Detected by Nuclear Radiation, Rehovot and Jerusalem, Israel.

8147 (COO-2012-8) BIOCHEMICAL STUDIES ON THE OCULAR LENS IN RELATION TO CATARACTOGENESIS. Progress Report No. 8, February 1, 1970–January 31, 1971. Kinsey, V. Everett; Reddy, V. N. (Oakland Univ., Rochester, Mich. Inst. of Biological Sciences). 23p. Dep. NTIS.

8148 (HUX-3780-30) QUANTUM THEORY OF (H,H_2) SCATTERING: APPROXIMATE TREATMENTS OF REACTIVE SCATTERING. Tang, K. T. (Columbia Univ., New York. Dept. of Physics); Karplus, M. (Harvard Univ., Cambridge, Mass. Dept. of Chemistry). [1970]. 51p. Dep. NTIS.

8149 (HUX-3780-31) NONEQUILIBRIUM CONTRIBUTION TO THE RATE OF REACTION. III. ISOTHERMAL MULTICOMPONENT SYSTEMS. Shizgal, B. (Harvard Univ., Cambridge, Mass. Dept. of Chemistry. Leiden Rijksuniversiteit (Netherlands). Kamerlingh Onnes Laboratorium); Karplus, M. (Harvard Univ., Cambridge, Mass. Dept. of Chemistry). [1970]. 21p. Dep. NTIS.

8150 (LA-tr-70-14) BEHAVIOR OF NIOBIUM IN AN ANIMAL ORGANISM. Semenov, D. I.; Balashova, G. N.; Borisova, N. N. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Tr. Inst. Ekol. Rast. Zhivotn.; No. 46, 5-12(1966). 12p. Dep. CFSTI.

8151 (MLM-1764) LATTICE ENERGY CALCULATIONS FOR THE ALKALI HYDRIDES. Bowman, R. C. Jr. (Mound Lab., Miamisburg, Ohio). 21 Dec 1970. Contract AT(33-1)-Gen-53. 21p. Dep. NTIS.

8152 (NP-18537) SCALE CONTROL IN HIGH TEMPERATURE DISTILLATION UTILIZING FLUIDIZED BED HEAT EXCHANGERS. Hatch, L. P.; Weth, G. G. (Brookhaven National Lab., Upton, N. Y.). Jul 1970. Contract 14-01-0001-1151. 61p. GPO $0.65.

8153 (NYO-3590-6) PHYSIOPATHOLOGY OF BLOOD PLATELETS AND THE DEVELOPMENT OF PLATELET EXTRACTS AND SUBSTITUTES. Progress Report, August 1, 1969–July 31, 1970. Baldini, Mario G. (Brown Univ., Providence, R. I. Div. of Hematologic Research). Contract AT(30-1)-3590. 17p. Dep. NTIS.

8154 (NYO-4140-1) ANALYSIS OF THE EFFECT OF TERRAIN IRREGULARITIES ON TURBULENCE AND DIFFUSION IN THE SURFACE BOUNDARY LAYER. Final Report. Bowne, Norman E.; Entrekin, Herbert D.; Anderson, Gerald E. (Travelers Research Corp., Hartford, Conn.). Oct 1970. Contract AT-(30-1)-4140. 148p. Dep. NTIS.

8155 (ORNL-4595) KWIC INDEX FOR THE NUMERICAL TREATMENT OF NONLINEAR EQUATIONS. Householder, A. S. (Oak Ridge National Lab., Tenn.). Nov 1970. Contract W-7405-eng-26. 129p. Dep. NTIS.

8156 (ORNL-4624) DYNAMIC PROGRAMMING APPROACH FOR DETERMINING THE OPTIMAL DISPATCHING SEQUENCE FOR A COMBINED HYDRO-THERMAL-PUMPED-STORAGE UTILITY SYSTEM. Joy, David S. (Oak Ridge National Lab., Tenn.). Nov 1970. Contract W-7405-eng-26. 36p. Dep. NTIS.

8157 (ORNL-TM-3073) CONCENTRATION AND DESALTING OF PROTEIN SOLUTIONS PROGRAM. Progress Report for the period December 1, 1969–February 28, 1970. Hancher, C. W.; Ryon, A. D.; Rogers, F. L. (Oak Ridge National Lab., Tenn.). Dec 1970. Contract W-7405-eng-26. 25p. Dep. NTIS.

8158 (ORNL-tr-2376) ENVIRONMENTAL MANAGEMENT: RESEARCH PLANNING. (Centrale Organisatie TNO, The Hague (Netherlands)). Translated for Oak Ridge National Lab., Tenn., from a Dutch report. 74p. Dep. CFSTI.

8159 (ORNL-tr-2404) COMPARATIVE STUDY OF THE KESTNER FALLING-FILM EVAPORATION PROCESS IN THE DESALINATION OF SEAWATER. Leleu, R.; Emig, R.; Lauro, F. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from pp 325-35 of 3rd International Symposium on Fresh Water from the Sea, Dubrovnik, Yugoslavia, September 13–17, 1970. 9p. (CONF-700926-1). Dep. NTIS.

8160 (ORO-1637-19) ORIGIN AND FATE OF THE THIOCYANATE GROUP IN METABOLISM. Progress Report, May 1, 1969–October 31, 1970. Wood, John L. (Tennessee Univ., Memphis. Dept. of Biochemistry). Contract AT(40-1)-1637. 15p. Dep. NTIS.

8161 (ORO-2907-73) STUDIES IN THE PHYSICAL CHEMISTRY OF SELECTED HIGH-TEMPERATURE SYSTEMS. Progress Report, December 1, 1969–November 30, 1970. Margrave, John L.; Brooks, Philip R. (Rice Univ., Houston, Tex.). Contract AT(40-1)-2907. 8p. Dep. NTIS.

8162 (ORO-3651-7) ELECTRON-HOLE RECOMBINATION TIME IN A METAL. Special Progress Report. Gossick, B. R. (Kentucky Univ., Lexington. Dept. of Physics and Astronomy). [nd]. Contract AT(40-1)-3651. 16p. Dep. NTIS.

8163 (ORO-3897-2) PROGRESS REPORT [ON PROPERTIES OF METALS AND ALLOYS], DECEMBER 1, 1969–DECEMBER 1, 1970. (North Carolina Univ., Chapel Hill). Contract AT(40-1)-3897. 36p. Dep. NTIS.

8164 (RLO-2225-T-5-1) THEORETICAL GENETIC EFFECTS OF GEOGRAPHIC STRUCTURE IN NATURAL POPULATIONS. Annual Progress Report. Felsenstein, Joseph (Washington Univ., Seattle. Dept. of Genetics). 31 Jul 1970. Contract AT(45-1)-2225. 6p. Dep. CFSTI.

8165 (SAN-310-P-3-25) CLAY-METAL ASSOCIATIONS IN SUBARCTIC AND ARCTIC MARINE ENVIRONMENTS. Work in Progress, June 1970. Burrell, D. C. (ed.) (Alaska Univ., College. Inst. of Marine Science). Contract AT(04-3)-310. 90p. (R-70-10). Dep. NTIS.

8166 (SC-DC-69-3019) ROLE OF THE PRIOR DISTRIBUTION IN BAYESIAN DECISION MAKING FOR THE BINOMIAL SITUATION. Prairie, R. R. (Sandia Labs., Albuquerque, N. Mex.); Zimmer, W. J. (New Mexico Univ., Albuquerque). [1968]. 30p. (CONF-700702-2). Dep. NTIS.
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Germanic	ä appears as	ae
Germanic	ö	oe
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SUBJECT INDEX

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The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are specific materials, things, and processes. The headings are followed by modifiers that describe the properties of, or processes applied to, the headings.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE. In general, the nomenclature used is that of the subject indexes to *Chemical Abstracts*.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MANGANESE FLUORIDES
MANGANESE FLUORIDES MnF_2
MESONS
MESONS (π)
MESONS (ρ)
1-PENTANOL
2-PENTANOL

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—sorption by charcoal should be read "hydrogen sorption by charcoal." As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—yields in radiolysis of ethyl ether, effects of deuterium on, should be read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and URANIUM—crystal structure of, effect of cooling rate on allotropic transformations in, should be read "effect of cooling rate on allotropic transformations in crystal structure of uranium."

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Organic compounds are indexed by subject headings based on the indexes to *Chemical Abstracts* except in the area of enzymes, in which specific enzymes, named according to the 1964 recommendations of the International Union of Biochemistry, are used. In many cases nonproprietary names for drugs are used as subject headings, and cross references are made from the systematic chemical names. Subject headings for hormones appear in the inverted style at HORMONES.

Nomenclature of Life Sciences

Subject headings for plants are names of phyla with one exception: members of the Phylum Tracheophyta are indexed under class or subclass names. Scientific names (genus and species) are used as the initial, or file, word in the modifying phrase. Scientific names are omitted only when the name is not available in the literature or cannot be found in available references.

Subject headings for animals are the names of phyla with the following exceptions: (1) members of Phylum Arthropoda and Phylum Chordata are indexed under appropriate class name, and (2) common names are used for members of Class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are DISEASES; DISEASES, INFECTIOUS; DISEASES, NEOPLASTIC; DISEASES, PHYSIOLOGICAL; DISEASES, PLANT; and DISEASES, TRAUMATIC.

Diseases of mixed etiology are treated in the following manner: neoplastic diseases that are also classified as infectious or physiological are indexed under DISEASES, NEOPLASTIC; diseases in which a microorganism is the etiologic agent are classified under DISEASES, INFECTIOUS; physiological anomalies that are neither neoplastic nor infectious are indexed under DISEASES, PHYSIOLOGICAL; the acute radiation syndrome, nonspecific radiation injuries, trauma, and wounds or incisions inflicted mechanically are indexed under DISEASES, TRAUMATIC.

Specific diseases or pathological conditions are named in the file-word position of the modifier, in the author's terminology, and are set off from the remainder of the modifier by commas. Neoplasms are designated as benign or malignant in the file-word position when more specific information is not available.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V,...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

```
LEAD TITANATES
  PbTiO3--PbZrO3
LEAD ZIRCONATES
  PbTiO3--PbZrO3
```

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
Al_2O_3--Cu, ...

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
acetic acid--BF_3, ...
BORON FLUORIDES
acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
bromophenol--chlorobenzene, ...
PHENOL, BROMO-
bromophenol--chlorobenzene, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
deposition on nuclear fuel particles
molecular structure of
neutron total cross section for
sorptive properties for xenon
Young's modulus for
Al--C--Cr, superconductivity in
B--C, phase studies for
C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of Rosenfeld, et al. *Data on Particles and Resonant States*, UCRL-8030 (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, $\Lambda K(1700)$ enhancement in, (E)
BARYONS, RESONANCE (N^*)
production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERFRAGMENTS
binding energy of $\Lambda\Lambda$-He^6, three-body o--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS (TRIPLET)
hadron total cross sections in quark, numerical analysis of
CURRENT ALGEBRA
PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow e + \nu + \gamma$ decay
REGGE POLE THEORY
predictions for polarization in $K^- + p \rightarrow$ anti $K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta + n interactions at high energies
SYMMETRY GROUPS
SU(2) × SU(4) intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (1) or (2) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

XUM

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Reports, conference papers and proceedings, numbered translations, and patents are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show which reports are on file in the institutions listed on the back of the front cover (Dep.), which reports have been published in open-literature journals (journal citation), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, the availability is given under the primary number, and a cross reference is given under the secondary report number.

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CERN

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If published proceedings are received after the receipt of individual papers, the complete proceedings will be abstracted and the abstract number will appear in this index with the base CONF number.

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	25-6721	Muenchen-Berlin-Wien; Urban and Schwarzenberg (1968). 522p. DM 99.60
CONF-680606-		(Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France, June 24-26, 1968)
	25-6480	Paris; Presses Universitaires de France (1969). 397p
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	25-6471	See NBS-SPEC. PUBL-331
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CONF-700803-		(5th Symposium on Detonation, Pasadena, Calif., Aug. 18-21, 1970)
8	25-8183	See UCRL-7216C
CONF-700805-		(4th International Heat Transfer Conference, Versailles, France, Aug. 29-Sept. 5, 1970)
3	25-6464	See CEA-CONF-1648
CONF-700806-		(15th International Conference on High Energy Physics, Kiev, U.S.S.R., Aug. 26-Sept. 4, 1970)
41	25-7705	See IC-70/106
50	25-7611	See JINR-E1-5439
51	25-7554	See UCRL-19790
52	25-7777	See UCRL-20084
CONF-700810-		(Symposium on Environmental Aspects of Nuclear Power Stations, New York, N.Y., Aug. 10-14, 1970)
41	25-7980	Dep. CFSTI (U. S. Sales Only)
CONF-700817-		(4th European Conference on Controlled Fusion and Plasma Physics, Rome, Italy, Aug. 31-Sept. 4-19, 1970)
25	25-7364	See COO-1726-54
CONF-700819-		(2nd International Conference on the Strength of Metals and Alloys, Pacific Grove, Calif., Aug. 30-Sept. 4, 1970)
7	25-8181	See UCRL-20320
8	25-6882	See JAERI-Memo-4124
CONF-700826-		(Conference on Hybrid Computation, Munich, Germany, Aug. 31-Sept. 4, 1970)
4	25-6463	See CEA-CONF-1592
CONF-700828-		(4th International Heat Transfer Conference, Paris, France, Aug. 31-Sept. 5, 1970)
2	25-6466	See UCRL-71569
CONF-700829-		(Conference on Potential Energy Surfaces in Chemistry, Santa Cruz, Calif., Aug. 10-13, 1970)
1	25-8174	See SRIA-115-P-78-6
CONF-700830-		(3rd National Symposium on Fracture Mechanics, Pittsburgh, Pa., August 1970)
1	25-8184	See UCRL-72335
CONF-700831-		(General Assembly CIRP, Turin, Italy, Aug. 28-Sept. 6, 1970)
1	25-8185	See UCRL-72380
CONF-700903-		(4th Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden, Sept. 21-23, 1970)
2	25-6845	Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 5-11(Jul-Aug 1970)
3	25-8082	Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 43-9(Jul-Aug 1970)
4	25-6846	Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 27-34(Jul-Aug 1970)
5	25-6847	Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 35-42(Jul-Aug 1970)

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6	25-6416	Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 84, 50-62(Jul-Aug 1970)
CONF-700906-		(2nd International Conference on Numerical Methods in Fluid Dynamics, Berkeley, Calif., Sept. 15-19, 1970)
3	25-8186	See UCRL-72806
CONF-700912-		(5th Annual Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., Sept. 21-25, 1970)
7	25-7418	See UCRL-72317
8	25-7352	See UCRL-72330
9	25-7419	See UCRL-72329
CONF-700916-		(Proceedings of the Royal Society, London, England, Sept. 8, 1970)
	25-7580	Proc. Roy. Soc. (London), Ser. A; 318: 245-399(8 Sep 1970)
CONF-700926-		(3rd International Symposium on Fresh Water from the Sea, Dubrovnik, Yugoslavia, Sept. 13-17, 1970)
1	25-8159	See ORNL-tr-2404
CONF-700928-		(6th Symposium on Fusion Technology, Aachen, Germany, Sept. 22-26, 1970)
1	25-7407	See CEA-CONF-1663
2	25-7406	See CEA-CONF-1662
3	25-7405	See CEA-CONF-1661
4	25-7408	See CEA-CONF-1664
5	25-7409	See CEA-CONF-1665
CONF-700929-		(Proton Linear Accelerator Conference, Batavia, Ill., Sept. 28-Oct. 2, 1970)
1	25-7776	See UCRL-19932
2	25-7775	See UCRL-19901
CONF-700933-		(Conference on Hyperfine Interactions Detected by Nuclear Radiation, Rehovot and Jerusalem, Israel, Sept. 6-11, 1970)
1	25-7441	See CEA-CONF-1645
3	25-8145	Dep. NTIS
4	25-8146	Dep. NTIS
CONF-700934-		(2nd International Conference on the Science of Materials, Tremezzo, Italy, Sept. 13-25, 1970)
2	25-8065	See BNWL-SA-3427
CONF-700935-		(Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo., Sept. 21-23, 1970)
1	25-6856	See ORNL-TM-3055
CONF-701017-		(14th Annual Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 13-15, 1970)
1	25-6265	See NLCO-1078
CONF-701019-		(CREST Meeting on Reactivity Effects in Large Power Reactors, Ispra, Italy, Oct. 28-30, 1970)
1	25-8058	See TRG-Report-2060
CONF-701102-		(Meeting of the American Nuclear Society, Washington, D.C., Nov. 15-19, 1970)
2	25-6379	See DUN-SA-145
3	25-6449	See UCRL-72568
4	25-6522	See UCRL-72445
CONF-701106-		(5th Annual Midyear Topical Symposium on Health Physics Aspects of Nuclear Facility Siting, Idaho Falls, Idaho, Nov. 3-6, 1970)
3	25-6661	See BNWL-SA-3203
4	25-7778	See UCRL-20131
CONF-701108-		(Meeting of the Division of Particles and Fields of the American Physical Society, Austin, Tex., Nov. 5-6, 1970)
2	25-7552	See COO-1195-201
CONF-701109-		(IEEE Nuclear Science Symposium, New York, N.Y., Nov. 4-6, 1970)
2	25-6532	See BNWL-SA-3365
CONF-701111-		(Electron and Atomic Physics Division Meeting, Seattle, Wash., Nov. 23-25, 1970)
2	25-6345	See BNWL-SA-3526
CONF-701112-		(Symposium on New Developments in Physical and Biological Radiation Detectors, Vienna, Austria, Nov. 23-27, 1970)
1	25-6533	See BNWL-SA-3397
COO-		
1195-201	25-7552	Dep. NTIS
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44	25-7963	Dep. NTIS
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46	25-8007	Dep. NTIS
47	25-7965	Dep. NTIS
48	25-7966	Dep. NTIS
DOCKET-50247-	(Indian Point Nuclear Generating; See also DOCKET-50286) (Non-AEC)	
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DOCKET-50249-	(Dresden Nuclear Power Station; See also DOCKET-50237) (Non-AEC)	
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29	25-8013	Dep. NTIS
DOCKET-50270-	(Oconee Nuclear Station, See also DOCKET-50269, and DOCKET-50287) (Non-AEC)	
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29	25-8015	Dep. NTIS
30	25-8016	Dep. NTIS
31	25-8017	Dep. NTIS
32	25-8018	Dep. NTIS
33	25-8019	Dep. NTIS
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26	25-8013	See DOCKET-50269-29
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29	25-8020	Dep. NTIS
DOCKET-50295-	(Zion Station Nuclear Power Plant. See also DOCKET-50304) (Non-AEC)	
20	25-8021	Dep. NTIS
21	25-8022	Dep. NTIS
DOCKET-50304-	(Zion Station Nuclear Power Plant. See also DOCKET-50295) (Non-AEC)	
20	25-8021	See DOCKET-50295-20
21	25-8022	See DOCKET-50295-21
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DOCKET-50315-	(Donald C. Cook Nuclear Power Plant, See also DOCKET-50316) (Non-AEC)	
25	25-8024	Dep. NTIS
DOCKET-50316-	(Donald C. Cook Nuclear Power Plant, See also DOCKET-50315) (Non-AEC)	
25	25-8024	See DOCKET-50315-25
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21	25-8026	Dep. NTIS
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22	25-8027	Dep. NTIS
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DOCKET-50352-	(Limerick Generating Station) (See also DOCKET-50353) (Non-AEC)	
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10	25-8029	See DOCKET-50352-10
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8	25-8030	See DOCKET-50358-9
DOCKET-50361-	(San Onofre Nuclear Generating Station) (Units 2 and 3) (See also Docket-50362) (Docket-50206) (Unit 1) (Non-AEC)	
12	25-8031	Dep. NTIS
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11	25-8031	See DOCKET-50361-12
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DOCKET-50366-	(Edwin I. Hatch Nuclear Plant, Unit 2, Non-AEC)	
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DOCKET-50368-	(Arkansas Nuclear One) (Non-AEC) (Unit 2)	
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DOCKET-50369-	(McGuire Nuclear Station) (See also DOCKET-50370) (Non-AEC) (Units 1 and 2)	
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DOCKET-50370-	(McGuire Nuclear Station) (See also DOCKET-50369) (Non-AEC) (Units 1 and 2)	
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